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Abstract

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Military Satellite Communications Decision Support System Requirements Analysis and User Interface Design

by

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Major, United States Marine Corps
B.S., United States Naval Academy, 1980

Submitted in partial fulfillment of the
requirements for the degree of

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June 1993

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PREFACE

The user interface prototype developed in this research runs on IBM PC-compatible microcomputers equipped with Microsoft *Windows* (Version 3.1). Requests for software should be submitted to the Command, Control, Communications Academic Group, Naval Postgraduate School, Monterey, California 93943-5000. Software requests must be accompanied by a high density 3½ inch diskette and a pre-addressed disk mailer.

Because the acronyms used in this document may be unfamiliar to some readers, a fold-out glossary is provided in Appendix A for easy reference.

I. INTRODUCTION

The purpose of this research is to (i) define the functional requirements of a Military Satellite Communications Decision Support System (MDSS), (ii) propose a high-level functional architecture, and (iii) design a first iteration of the MDSS user interface for U. S. Space Command (USSPACECOM).[1]

Experience gathered during recent operations, such as Desert Shield/Desert Storm, suggests the need for a system that facilitates access to, and integration of, a diverse array of data and analysis tools in order to effectively manage Military Satellite Communications (MILSATCOM) resources while satisfying communications requirements. USSPACECOM has been using a number of computer-supported tools to manage its resources.[2] Although they have proved to be useful in aiding USSPACECOM analysts, it was acknowledged that these systems, as independent "islands" of information, lack integration and flexibility that could be gained with a seamless Decision Support System (DSS) environment. Historically, the MILSATCOM management tools were developed for addressing

---

[1] The term "requirements" will be used in two different ways. Here, it refers to the design requirements of the MDSS. "Requirements" will also be used when referring to the needs (requirements) of communications users. The context will guide the reader in identifying the intended usage.

[2] Appendix B provides a table describing each of the software tools currently in use.

specific decision problems. As communications users gain more experience with these software tools, they now realize the necessity of having an integrated system capable of bringing the various tools together into a single platform where they can function together, with the output of one tool serving as the input to others. The MDSS is intended to satisfy this requirement.

As part of the MDSS development effort, this research seeks to summarize USSPACECOM missions related to MILSATCOM management (Chapter II), define the MDSS system specifications necessary to support USSPACECOM operational management and strategic decisions (Chapter III), propose an MDSS functional architecture (Chapter IV), and derive information displays and a user interface prototype (Chapter V).

II. OVERVIEW OF THE USSPACECOM MISSION

An understanding of organizational roles, missions, and responsibilities is necessary in order to accurately specify the requirements for an information system (e.g., Davis and Olson, 1985).

This chapter begins with a survey of the statutes, policies, and regulations that are germane to MILSATCOM management. The survey will serve as the background for an illustration which describes the functional relationships between organizations in the satellite communications community. Finally, some conclusions will be drawn about the utility of a decision support system in helping USSPACECOM manage military satellite communications.

A. MISSION-DEFINING DOCUMENTS

Military satellite communications management responsibilities can be derived from several high level documents. Interviews with officers involved in MILSATCOM management at USSPACECOM, the Joint Staff, the National Communications System, and the Defense Information Systems Agency suggest that, although not exhaustive, the following documents are relevant to understanding MILSATCOM management. Table 1 provides an interpretation of the documents to the extent that they apply to USSPACECOM.

Table 1 SUMMARY OF MILSATCOM MANAGEMENT DOCUMENTS

Document	Summary of mission impact
Goldwater-Nichols Act (1986)	Grants USSPACECOM authority over component commands to direct all aspects of military operations, joint training, and logistics (Title 10, USC, 1986).
Joint Strategic Capabilities Plan (1991)	Sets forth objectives, planning considerations, and tasks for USSPACECOM, especially in its role of supporting the National Command Authorities (NCA) and other unified and specified commanders in chief (CINCs) in their mission areas (JSCP, 1991).
National Military Strategy Document (1992)	Articulates strategy and provides guidance on the capabilities necessary to support national military strategy, serving as the basis for development of military Service and DoD agency Program Objective Memorandum (POM) submissions. Among the areas identified as needing greater emphasis is that of adaptability and strategic agility of Command, Control, Communication, and Computers (C^4) . With the shift in focus of the military strategy to a regional orientation, C^4 support must be modular and flexible with the capability for crisis surge in communications throughput via a mix of Government, allied, and commercial resources. To this end, the Chairman of the Joint Chiefs of Staff (CJCS) established a priority objective for systems that improve centralized C2 and management of space support operations under USSPACECOM (NMSD, 1992).

Document	Summary of mission impact
Military Satellite Communications Systems (1992)	• Provides operational objectives, policies, procedures, and guidance on MILSATCOM systems. • Highlights the use of MILSATCOM systems in support of the national military strategy within the context of the overall military communications architecture (terrestrial and other non-satellite paths). • Sets forth the principle that "constrained resources will be applied against CJCS-validated and prioritized connectivity requirements for maximum mission requirement satisfaction." • Assigns responsibilities, defines the process for validating communications requirements, and establishes the objective to prepare standardized, streamlined, and operationally responsive MILSATCOM management and controls to "optimize the allocation of communication resources." • Provides detailed assignment of responsibilities to USSPACECOM which can be summarized as follows: · Assess each CINC's MILSATCOM requirements and advocate systems that support those requirements. · Conduct space operations. · Support DISA in satellite communications architecture development (MOP 37, 1992).
Military Satellite Communications Command and Control Operations Concept (1988)	• Establishes the concept for MILSATCOM C2 and defines responsibilities and organizational relationships of the commands involved in MILSATCOM C2. • Assigns USSPACECOM responsibilities: · Planning for and executing health, status, tracking, station-keeping, and survivability of space segment. · Executing communications payload commands. · Assessing the impact of satellite repositioning and reconfigurations and advising the Joint Staff (MJCS 11-88).

The MILSATCOM missions for USSPACECOM can be summarized as follows:

- Advise the Joint Staff
- Manage satellite constellations
- Conduct satellite operations
- Conduct ground station operations
- Assess communications requirements
- Support architecture development

To accomplish their missions, USSPACECOM currently performs the following roles:

- Assessment of communications requirements
- Constellation management
- Assessment of new architectures

In his February 1993 report to the Secretary of Defense on the Roles, Missions, and Functions of the Armed Forces, the Chairman of the Joints Chiefs of Staff (CJCS) recommended that the mission of USSPACECOM be assigned to STRATCOM, and that USSPACECOM be eliminated (CJCS, 1993). Should that recommendation be adopted, the basic tenets of the governing documents will

likely remain unchanged. In our opinion, they will only be managed under a different organizational name.

B. FUNCTIONAL ORGANIZATION OF THE SPACE COMMUNITY

MILSATCOM is currently being managed by a number of Defense organizations. The interdependence and interaction between these agencies can be best illustrated by describing the process used to validate communication requirements. Figure 1 provides a diagram of this process.

The requirements validation process begins with a communications user forwarding an operational, contingency, or future connectivity requirement through the chain of command to a supported Commander-In-Chief (CINC), military Service, or DoD agency. The CINC, Service, or agency studies the requirements and, if approved, the requirement is submitted to the Joint MILSATCOM Panel via on-line entry in the Integrated Satellite Communications Database (ISDB), maintained by the Defense Information Systems Agency (DISA) MILSATCOM Office (MSO) functioning in the role of MILSATCOM Panel Administrator. Supervised and chaired by the Joint Staff and composed of representatives from each of the Armed Services, the MILSATCOM Panel distributes the new requirement to satellite system operational managers for technical and operational assessment to determine the capability of current or programmed systems to satisfy the requirement. DISA will assess the potential for satisfying requirements via

alternate media (terrestrial resources). Some of the major system managers are shown in Table 2.[3]

Table 2 MAJOR MILITARY SATELLITE COMMUNICATIONS SYSTEMS

Satellite System	System Manager	System Characteristics
Defense Satellite Communications System (DSCS)	Army	Intended to support strategic communication for early warning and world-wide military command and control.
Fleet Satellite Communications System (FLTSATCOM)	Navy	Designed to provide multi-channel, anti-jam protected UHF broadcast to Navy ships and digital links between shore stations. Each satellite vehicle has 23 UHF channels: 10 FLTSATCOM, 12 AFSATCOM, and one wide-band for the National Command Authority.
Air Force Satellite Communications System (AFSATCOM)	Air Force	Supports Air Force bombers and launch control centers, airborne command posts, and some Army units. Shares satellite vehicle with FLTSATCOM in geosynchronous orbit and other DoD satellites in highly elliptical orbit, allowing support to Polar regions.
Military Strategic-Tactical and Relay (MILSTAR)	Air Force	Follow-on to DSCS, providing global EHF coverage from supersynchronous orbit. These processing satellites would be mutually linked, protected from nuclear effects, and able to survive ground launched interceptions.

At its monthly meeting, the MILSATCOM Panel considers the assessments provided and, if it approves, a validation number is entered in the ISDB for the connectivity requirement. The communications user can then use the validation

[3] Should DMRD 918 be implemented, DISA may assume system manager responsibility for the systems listed in Table 2.

number as authority when submitting requests to satellite system operational managers for access to the MILSATCOM space segment. USSPACECOM periodically evaluates the database of validated requirements and provides a space assessment to the Chairman of the Joint Chiefs of Staff. A separate assessment is provided to DISA in which USSPACECOM advocates for future MILSATCOM systems in support of CINC requirements. DISA uses this assessment for developing architectures of future MILSATCOM systems.

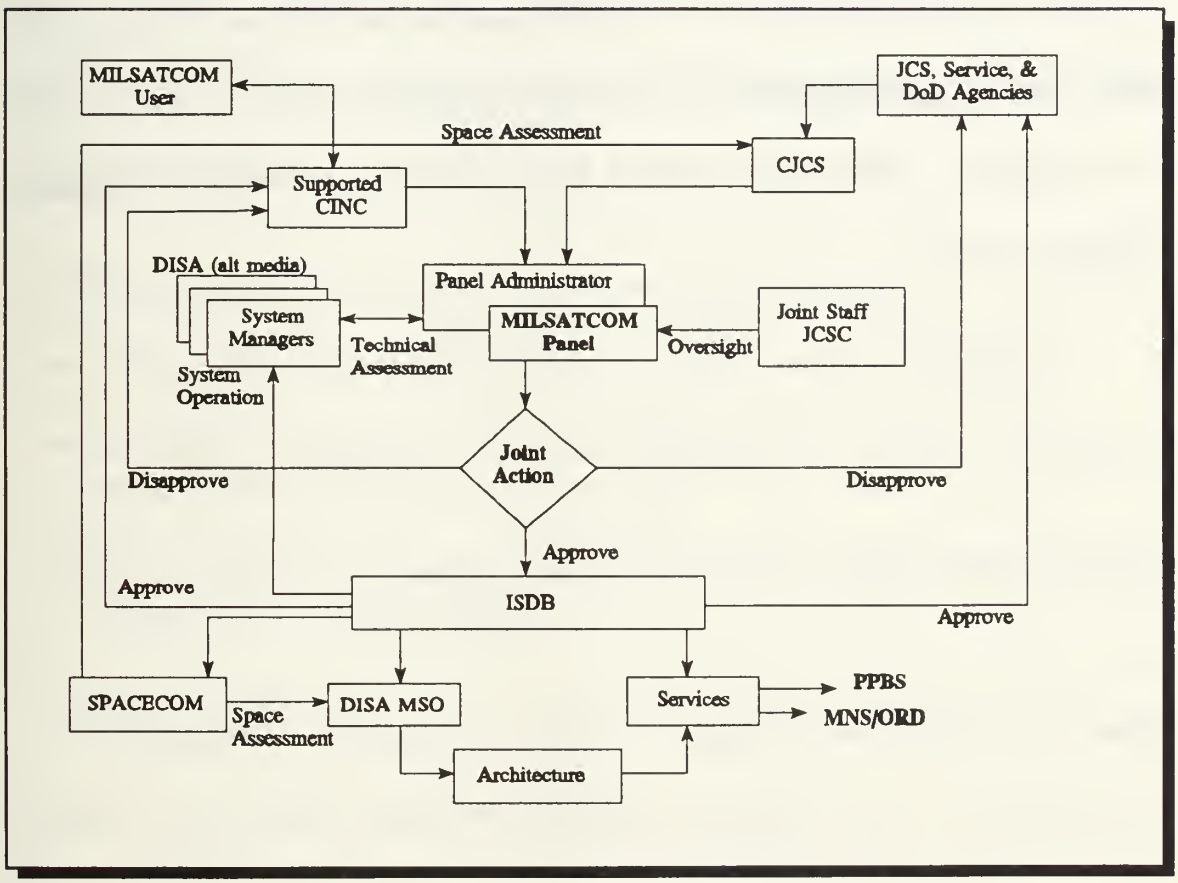

Figure 1 MILSATCOM Requirements Processing

C. USSPACECOM MISSIONS AND DECISION SUPPORT TECHNOLOGY

There appears to be a dominant message from these governing documents: information technology should be used to facilitate the efficient and effective management of communications systems in support of national objectives. In fact, the diversity of information necessary to manage MILSATCOM resources, the complexity of communications and satellite processes, and the operational urgency of DoD missions demand the use of responsive automated information systems that allow policy makers, architects, and operational managers to use analysis tools that can manipulate a wide range of data to produce information displays in support of decision making.

III. DETERMINATION OF MDSS SYSTEM REQUIREMENTS

A. AN INTEGRATED DECISION SUPPORT ENVIRONMENT

A typical Decision Support System (DSS) is made up of several classes of components intended to satisfy data retrieval, analysis, and display functions (e.g., Turban, 1993). As discussed earlier, there is a perceived need among USSPACECOM analysts to have a system that could integrate in a seamless environment a variety of existing well-proven computerized tools. The attempts to integrate these tools, however, face a number of problems:

- The tools were built to run on different operating systems.
- Each tool has its own embedded data, analysis tools, and displays.
- The tools were designed to function independently, having no facilities for linking or data exchange with other tools.
- Not all analysis tools and data sources necessary to support USSPACECOM missions have been developed.

Furthermore, as these tools will likely be improved and new software added, standards across systems must be established to alleviate some of the problems of

integrating component tools into the MDSS.[4] Although not an exhaustive list, we advocate the following standards as particularly important for the MDSS:

- *Platform standards*. In our opinion, if the MDSS is to be widely used within the MILSATCOM community, it must function on a hardware platform and in an operating system that is already available. Requiring potential users to purchase expensive new equipment and software will greatly reduce the likelihood that it will be widely adopted.

- *Data standards*. Component tools must share common data in order to produce results that are both consistent and reliable. Later in this chapter, specific data requirements will be specified.

- *Display standards*. Different components serving various purposes should display results in a format that is consistent from one tool to another. Chapter IV will address recommended user interface conventions in support of this principle.

- *Expandability standards*. Following initial implementation, unforeseen MDSS user requirements will be identified which can be satisfied by the development of new modular tool components that can be added to the MDSS with little or no involvement from MDSS system designers. Such an open architecture design will extend the useful service life of the MDSS.

- *Interoperability standards*. As the concept of "C4I for the Warrior" (CJCS, 1993) has greater influence on funding decisions for development of new systems like the MDSS, interoperability will become a critical issue. One area of interoperability that is especially important for the MDSS is that of sharing information and working cooperatively with decision aids used in managing terrestrial telecommunications paths. Since satellites are just one set of many paths in communications routing, apportionment decisions must involve all communications requirements and all connectivity paths. Thus, it is critical that the MDSS be capable of complete interoperability with other communication decision aids.

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[4] While the task of *integrating* component tools was not addressed in our research, this important step must be undertaken by software engineers when the MDSS is built.

B. METHODOLOGY FOR DEFINING SPECIFIC REQUIREMENTS

To determine an organization's requirements for an information system, the Critical Success Factors (CSF) method is widely recommended in the DSS literature (Rockart, 1979). This method was used to decompose USSPACECOM missions into goals and measurable critical success factors.

Having established top-level system requirements for the MDSS, we used the Representations, Operations, Memory Aids, and Controls (ROMC) method (Sprague and Carlson, 1982) to define specific DSS requirements. For each CSF, the ROMC method was used to derive the requirements of the MDSS user interface. Finally, we used the principles of GUI design as set forth by Bui (1987), Marcus (1990), and others to design displays to facilitate decision-making in support of each CSF. The methodologies are briefly described below.

1. The CSF Method

According to the CSF method, if the DSS builder wants to develop a DSS to support an organization, he must understand the organization's mission well enough to identify tangible goals which, in turn, help define success factors that are measurable and processable by the computer:

Mission→ Goal→ CSF

"Goals represent the end points that an organization hopes to reach. Critical success factors, however, are the areas in which good performance is necessary to ensure attainment of these goals" (Rockart, 1979). The key principle in this method is to identify tangible and measurable information that computers can help produce to assess the organization's performance.

2. The ROMC Method

The ROMC approach is a user-oriented framework for specifying the functional requirements of a DSS. Since there are a variety of decision-making approaches, a DSS should support multiple processes. The variety of decision types require different data processing modes. Accordingly, a DSS needs to provide computing flexibility in order to support an assortment of decision situations. The ROMC method seeks to ensure that the user is provided with a set of *representations* (e.g., graphical display of input/output) and *operations* (e.g., algorithms or heuristics) in a problem-solving environment (e.g., software commands to access corporate *memory*) where he can develop his own problem solving process by manipulating *controls* (e.g., sequencing operations and selecting representations). To allow the user the greatest flexibility in addressing decision problems, the DSS developer must identify (i) what are the most appropriate input/output modes, (ii) what are the models to be used, (iii) what are the data required to support the modeling process, and (iv) how the DSS can be structured

to help the user sequence operations and interpret results (Sprague & Carlson, 1982).

Note that ROMC approach calls for providing a decision-making *environment* without specifying a decision-making *process*. This point is particularly important for two reasons.

- *MDSS Will Have Multiple Users*. The MDSS with be operated by a variety of users, having a variety of decision making styles. An MDSS design that fully scripts the decision making process will frustrate many users, leading them to an sub-optimal decision.

- *Unforeseen Decision Problems Will Occur*. The MDSS must have the flexibility to address decision problems that were not foreseen at development time. A process-oriented design only allows designer-specified problems to be addressed. When a new problem comes along, the MDSS would have to be modified by the designer in order to accommodate the problem.

We suggest using a design approach that addresses both issues while also supporting process-oriented decision-making. An important benefit of the process-oriented design is that it is especially good for the new user who does not completely understand the system and has not developed a stable decision making style. By using pre-defined processes, built into the MDSS for commonly occurring scenarios, the user can better understand the system and begin to decide how he can best take advantage of the system's capabilities.

3. Combining CSF and ROMC

As discussed earlier, the CSF method is used to develop a set of computable measures to help decision makers monitor the performance of their organization with regard to their defined mission. From an information systems-oriented perspective, the ROMC method seeks to provide a framework that helps information system developers identify what kind of interfaces, algorithms, and data requirements are needed in order to provide the critical success factors to the users. Thus, we see the combination of CSF and ROMC as a natural transition to determine the DSS functional requirements:

Mission→ Goal→ CSF→ ROMC→ MDSS Specifications

C. MDSS REQUIREMENTS ANALYSIS

1. USSPACECOM Critical Success Factors

Table 3 reports the results of our application of the CSF method in defining success factors and measures for USSPACECOM. Table 4 uses these results to form the basis for defining the requirements of the MDSS. The tables were first developed through a study of governing documents and interviews with various officers and contractors involved in MILSATCOM management. The tables were later refined after review by USSPACECOM representatives.

From Chapter II, the MILSATCOM missions assigned to USSPACECOM were divided into three broad areas: (i) communications requirements assessment, (ii) space operations, and (iii) architecture evaluation. The first column of Table 3 lists these broad mission areas and then decomposes them so that specific goals may be applied. The second column identifies what steps USSPACECOM must take in order to accomplish each mission. For each goal, factors were listed in the third column that, when realized, would ensure that the applicable goal would be reached. In order to monitor progress toward achieving each goal, specific measures were developed, as shown in the fourth column.

Table 3 The Method of Critical Success Factors Applied to USSPACECOM Missions

Missions *"SPACECOM is responsible for..."*		Goals *"To accomplish its mission, SPACECOM's goal is..."*	Critical Success Factors *"To accomplish its goals, SPACECOM must have..."*	Measures *"To be successful, SPACECOM must..."*
Comm. Requirements Assessment	Strategic: recommending allocation of system capacity to user requirements.	To satisfy as many communications requirements as possible, in priority order, constrained by system resources.	A plan for assigning communications requirements to system resources.	Produce clear displays of system usage and communications requirements satisfied/not satisfied.
	Operational: recommending resource alternatives to satisfy communication requirements.	To choose alternatives that will improve communications support to the warfighter.	A plan for combining and adjusting resources to satisfy requirements.	Compare gain in communication requirements satisfaction with cost of alternatives (MILSATCOM satellite launch or re-positioning, use of commercial & allied SATCOM, or terrestrial paths).
Space Operations	Serve as combatant commander of space segment.	To provide responsive satellite communications support to the warfighter.	Management of satellite resources that reflects DoD operational priorities.	Compare satellite unused capacity with unsatisfied communications requirements.
	Monitoring status of constellations.	To know the current health, transponder loading, and expected service life of the satellites in each constellation.	Access to information about each satellite's design characteristics and performance history.	Receive accurate satellite design and performance history information.
			Access to satellite bus subsystem status information.	Receive accurate and timely satellite bus subsystem status information.
			Access to transponder loading information.	Receive accurate and timely transponder loading information.
	Granting access to the space segment.	To grant access to the space segment on the basis of validated and prioritized communications requirements.	Access to validated communications requirements information.	Support no unvalidated requirements.
			The capability to adjust the plan for apportioning satellite resources on the basis of new requirements.	Support no lower priority requirements while higher priority requirements remain unsatisfied.
	Restoring service following systems failure.	To determine the impact of losses in satellite capability.	Access to transponder loading information.	Receive accurate and timely transponder loading information.
		To satisfy as many communications requirements as possible, in priority order, constrained by remaining system resources.	The capability to adjust the plan for apportioning satellite resources on the basis of diminished resources.	Support no lower priority requirements while higher priority requirements remain unsatisfied.
Architecture Development	Projecting shortfall of existing systems in satisfying user requirements.	To determine the impacts of shortfalls of system resources in satisfying communications requirements.	A method for comparing system design characteristics, performance history, and current status with future communications requirements to determine the timing and magnitude of resource shortfalls.	Receive accurate system design, performance history, and current status information on space segment, space control segment, network control segment, and user terminal segment.
			A means to measure the cost of resource shortfalls.	Provide the means to measure shortfall costs that can be related to combat units, OpPlans, or equivalent commercial augmentation.
	Recommending new architectures to satisfy user requirements.	To determine the value of new architectures in satisfying communications requirements.	A means to compare the utility of new architectures with that of existing architectures.	Receive new architecture characteristics and, if required, models that are verified, validated, and accredited.

Table 4 The ROMC Method Applied to USSPACECOM Critical Success Factors

Consolidated Measures *"To be successful, SPACECOM must..."*	Data Sources *"MDSS must have access to..."*	Analysis Tools *"MDSS analyzes data with..."*	Screen Displays *"Users must be able to visualize..."*	Screen Manipulations *"Users must be able to navigate through displays to..."*
Produce clear displays of satellite usage and communications requirements satisfied/not satisfied.	1. Communication user requirements. 2. System design characteristics, performance history, and current status: a. Military space segment. b. Space control segment. c. Network control segment. d. User terminal segment. e. Civil/commercial satellites. f. Allied satellites. g. Terrestrial resources. 3. Threat data. 4. Geographic data.	1. An astrodynamic calculation tool to determine relative positions of users, geography, and satellites. 2. An assignment model able to map communications requirements into system resources. 3. A tool for comparing system capacity and communications require-ments and identifying shortfalls and excess capacity. 4. A scenario building facility for modeling the effects of satellite repositioning, OpPlan implementation, threat activity, and weather. 5. A tool for allowing direct access to data sources in order to conduct ad-hoc queries.	1. Allocation of system capacity over time. 2. System capacity shortfall. 3. Relative positions of satellites, satellite ground traces, satellite coverage swath, satellite control facilities, and communications users on 2D earth map. 4. Network diagram. 5. Bandwidth usage diagram.	1. Plot entities for analysis (time, geoloc, OpPlan, CINC, or constellation). 2. Measure capacity (# of networks, throughput rate, or cost) 3. Fix system resources while varying requirements. 4. Fix requirements while varying system resources. 5. Perform "what-if" analysis. 6. Measure costs (fuel, satellite longevity, combat units supported/ not supported, equivalent commercial augmentation).
Compare gain in communication requirements satisfaction with cost of alternatives (MILSATCOM satellite launch or re-positioning, use of commercial & allied SATCOM, or terrestrial paths).				
Compare satellite unused capacity with unsatisfied communications requirements.				
Provide the means to measure shortfall costs that can be related to combat units, OpPlans, or equivalent commercial augmentation.				
Receive accurate system design, performance history, and current status information on space segment, space control segment, network control segment, and user terminal segment.	Data Source 2.	6. A tool that reads text messages and enters data into data sources.	6. Satellite bus wire diagram depicting design characteristics. 7. Satellite bus status table showing RYG status of satellite components. 8. Transponder loading table showing circuits, ISDB #s, and other related information.	7. Examine constellation, satellite, or networks of interest.
Support no unvalidated requirements.	Data Sources 1 and 2c.	Analysis Tool 2.	Screen Displays 1-3.	Screen Manipulations 1-5.
Support no lower priority requirements while higher priority requirements remain unsatisfied.				
Receive new architecture characteristics and, if required, models that are verified, validated, and accredited.	Forecast of Data Sources 1-3 for new architectures.	Analysis Tools 1 and 2. 7. A tool to simulate the performance of new architectures. 8. A tool for determining the cost effectiveness of new architectures. 9. A tool for determining system survivability against future threats.		Screen Manipulations 1-6 applied to new architectures.

2. MDSS Representations, Operations, Memory Aids, and Controls

The *measures* developed in Table 3 were consolidated in Table 4 and became the basis for identifying the data sources (memory aids), analysis tools (operations), screen displays (representations), and screen manipulations (controls) needed to constitute a MILSATCOM Decision Support System.

The data source and analysis tool requirements were applied to a MDSS functional architecture in Chapter IV. Data source and analysis tool requirements listed in Tables 5 and 6, respectively, associate previously developed components with MDSS functional requirements. Requirements for which no data source or analysis tool could be identified were noted. These tables, then, can serve as a "checklist" for further research efforts.

Table 5 MDSS DATA SOURCE REQUIREMENTS

Data Source Requirements *"MDSS must have access to..."*	Availability	
	Data	Source
1. Communications user characteristics and requirements.	*MRDB*	ARINC
2a. System design characteristics: ●Military space segment		Satellite System Manager
●Space control segment		Satellite System Manager
●Network control segment		Satellite System Manager
●User terminal segment		
●Civil/commercial		
●Allied		
●Forecast for new architectures		DISA
2b. System performance history: ●Military space segment		Satellite System Manager
●Space control segment		Satellite System Manager
●Network control segment		
●User terminal segment		
●Civil/commercial		
●Allied		
●Forecast for new architectures		DISA
2c. System current status: ●Military space segment	*Catalog of Space Objects*	Space Surveillance Center
●Space control segment		
●Network control segment		
●User terminal segment		
●Civil/commercial		
●Allied		
3. Threat data: ●Near term		
●Forecast for new architectures		

Table 6 MDSS ANALYSIS TOOL REQUIREMENTS

Analysis Tools *"MDSS analyzes data with..."*	Availability	
	Tool	**Source**
1. An astrodynamic calculation tool to determine relative positions of users, geography, and satellites.	**Omni** **SATRAK**	**Autometric** **Teledyne Brown Engineering**
2. An assignment model able to map communications requirements into system resources.	**Not available to date** (Sub-elements available: *Comnet* from Aerospace for link calculations Elements of *SPDSS* from ARINC)	
3. A tool for comparing system capacity and communications requirements and identifying shortfalls and excess capacity.	**Not available to date**	
4. A scenario building facility for modeling OpPlan implementation.	**Not available to date**	
5. A tool for conducting ad-hoc queries of data sources.	Only available for the ***MRDB***	ARINC
6. A tool that reads text messages and enters data into data sources.	**Not available to date**	
7. A tool to simulate the performance of new architectures.	**Not available to date**	
8. A tool for determining the cost effectiveness of new architectures.	**Not available to date**	
9. A tool for determining system survivability against future threats.	**Not available to date**	

Note: Here, we are interested more in the functionalities that these systems provide than in their commercial aspects (i. e., hardware, maintenance, etc.)

Tables 7 and 8 provide user interface specifications for MDSS representation and control requirements. The tables served as a "checklist" during the design of a user interface shell. The user interface design will be addressed in greater detail in Chapter V.

The purpose of this chapter was to define graphical user interface requirements for the MDSS. We devised a structured approach to define MDSS-GUI requirements. MILSATCOM roles, missions, critical success factors, DSS interface requirements (i.e., representations), and DSS functional requirements (i.e., operations, memory, and controls) were studied respectively to form a rigorous foundation for specifying concrete, ready-to-be-implemented user interface specifications.

We contend that the proposed specifications, as outlined in Tables 3 through 8, if implemented properly, will provide a MDSS fully responsive to USSPACECOM's MILSATCOM mission.

Table 7 MDSS SCREEN DISPLAY REQUIREMENTS

Screen Display Requirement *"Users must be able to visualize..."*	**Implementation** *"MDSS builders must provide..."*
1. Allocation of system capacity	2D or 3D graphical plot allowing various XYZ axis selections: Vertical- System capacity or capacity shortfall. Horizontal- Time, OpPlan, geographic region, or CINC.
2. System Capacity shortfall.	
3. Relative positions of satellites, satellite control facilities, and users on earth map.	2D world (or subset) map overlaid with satellites, satellite control facilities, and user positions.
4. Communications network diagrams.	2D world (or subset) map overlaid with user positions and satellites connected to show network relationships.
5. Usable bandwidth diagram, based on longitude, satellite, or constellation.	Bandwidth usage diagram displayed in a window.
6. Satellite bus wire diagram depicting design characteristics.	Satellite wire diagram showing subsystems. Satellite design characteristics in a text window.
7. Satellite bus status table showing RYG status of satellite components.	Satellite wire diagram showing subsystems color-coded with RYG status. Satellite performance history, showing current and past subsystem status changes, in a text window.
8. Transponder loading table showing circuits, users, ISDB #s, and other related information.	Transponder loading table displayed in a window.

Table 8 MDSS SCREEN MANIPULATION REQUIREMENTS

Screen Manipulations *"Users must be able to navigate through displays to..."*	**Screen Manipulation Specifications** *"MDSS builders must provide..."*
1. Plot entities for analysis	Drop-down list for X and Z axes with choices of: time, geographic regions, CINC, operation plans, or constellation (include option to disable Z axis when 3D plot is not desired).
2. Measure capacity	Drop-down list with choice of: kbits/sec, Mbit/sec, # networks, # of voice circuits, # of T1 carriers, cost in dollars of equivalent commercial capacity (prompt user for current price of T1 service), # equivalent combat units supported (user selects Army Divisions, Marine MEBs, Navy Battle Groups, or Air Force Wings).
3. Fix system resources while varying requirements.	Vary requirements by: 1. Radio button to reduce requirement satisfaction from objective to threshold, 2. Menu selection for scenario generator to select OpPlan combinations, EW degradation, or Wx degradation.
4. Fix requirements while varying system resources.	Vary resources by: 1. Click and drag satellite repositioning. 2. Menu selection to assign requirements to another resource (terrestrial, civil-commercial satellite, allied satellite).
5. Perform "what-if" analysis.	Menu selection to allow direct access to databases for queries.
6. Examine constellation, satellite, or networks of interest.	Drop-down lists to select constellation, satellite, or network.
7. Measure costs	Drop-down list for choice of cost measurement units: cost in dollars of equivalent commercial capacity (prompt user for current price of T1 service), # equivalent combat units supported (user selects Army Divisions, Marine MEBs, Navy Battle Groups, or Air Force Wings).

IV. FUNCTIONAL ARCHITECTURE

In the previous chapter, we used a structured approach to derive a set of high-level functional requirements for the MDSS. Our approach suggests that if an MDSS satisfies those requirements, it will in fact respond to the needs of USSPACECOM. This chapter discusses various functional architectures, at the system level, that could be conceived to satisfy those requirements.

A. DESIGN ALTERNATIVES

A DSS integrates component tools in order to support decision making. Frequently, the output of one tool becomes the input to another tool. Accordingly, component tools must be capable of functioning cooperatively. Such integration may be achieved in a variety of ways.

1. Federation-of-Systems Architecture

A federation-of-systems architecture could exist by operating components separately so that the user *manually* transcribes the output of one component to the input from of another component. The concept of this architecture is illustrated in Figure 2. The examples of component tools shown (*MRDB, SPDSS, and Comnet*) are described in Appendix B.

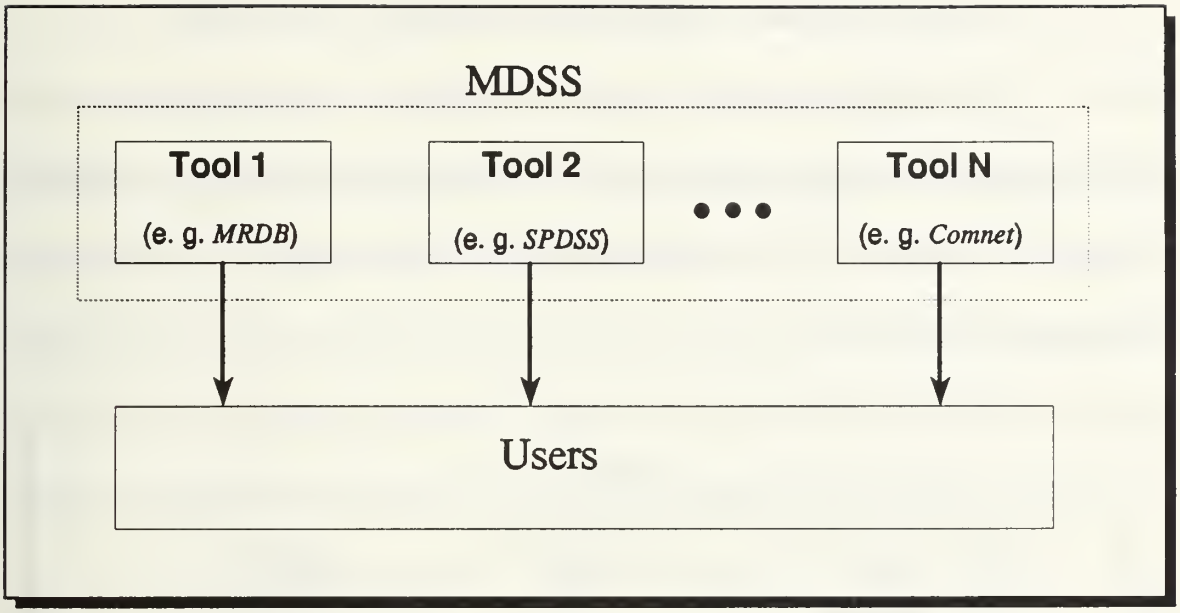

Figure 2 Federation of Systems Architecture

This architecture is a quick development strategy that can take advantage of existing (sub)systems already developed. Its implementation is rather simple and allows component tools to retain their proprietary integrity. This is, more or less, the way MILSATCOM analysis tools are currently used. The disadvantages of this architecture are that it requires multiple sources for the same displays and data, and it requires the user to manually integrate component tool outputs. Forcing users to continuously adapt themselves to different systems during a decision analysis is known to be counterproductive. Also, maintaining separate and heterogenous databases poses serious maintenance problems.

2. Fully Integrated Architecture

At the other end of the spectrum is a fully integrated architecture that could be built by re-engineering the code of all existing tools into a new and single integrated application. The concept of the fully integrated architecture is illustrated in Figure 3.

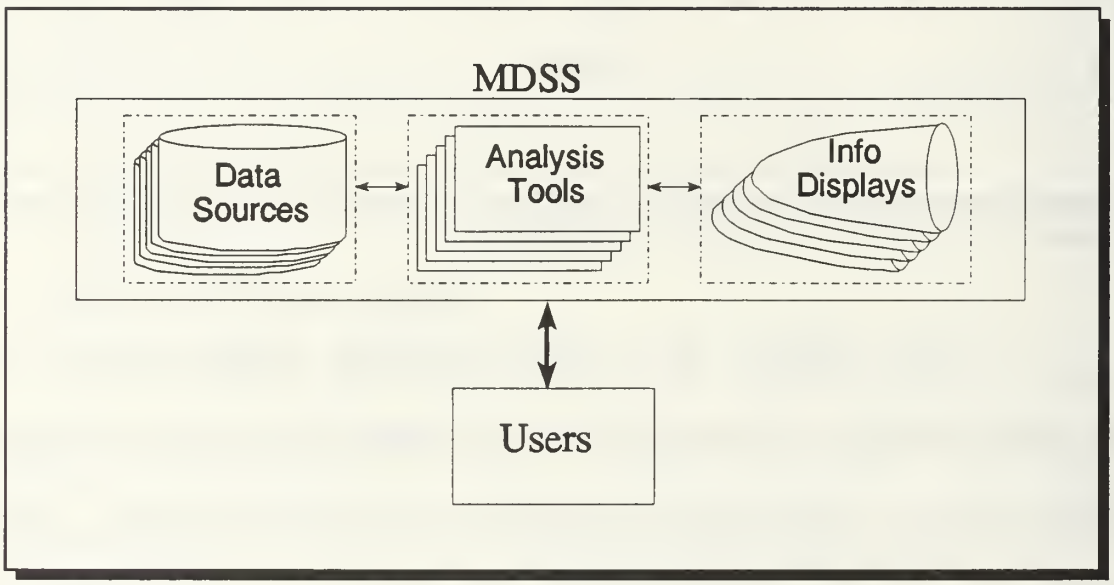

Figure 3 Fully Integrated Architecture

This architecture would solve the problems of multiple data sources and component integration, but would dramatically increase the cost of software development and user training. High costs could outweigh the potentially marginal benefits gained from such an integration. Long run maintenance cost is, however, expected to be significantly less than that of the federation-of-systems architecture.

3. "Sandwich" Architecture

The "sandwich" architecture serves as a compromise of the federation and fully integrated architectures. As shown in Figure 4, existing, as well as future component tools are imbedded in a common user interface platform and a seamless data source environment. As such, it allows individual component tools to retain their proprietary integrity, minimizing the need for re-coding software, while providing for single data sources and standard user interface displays.

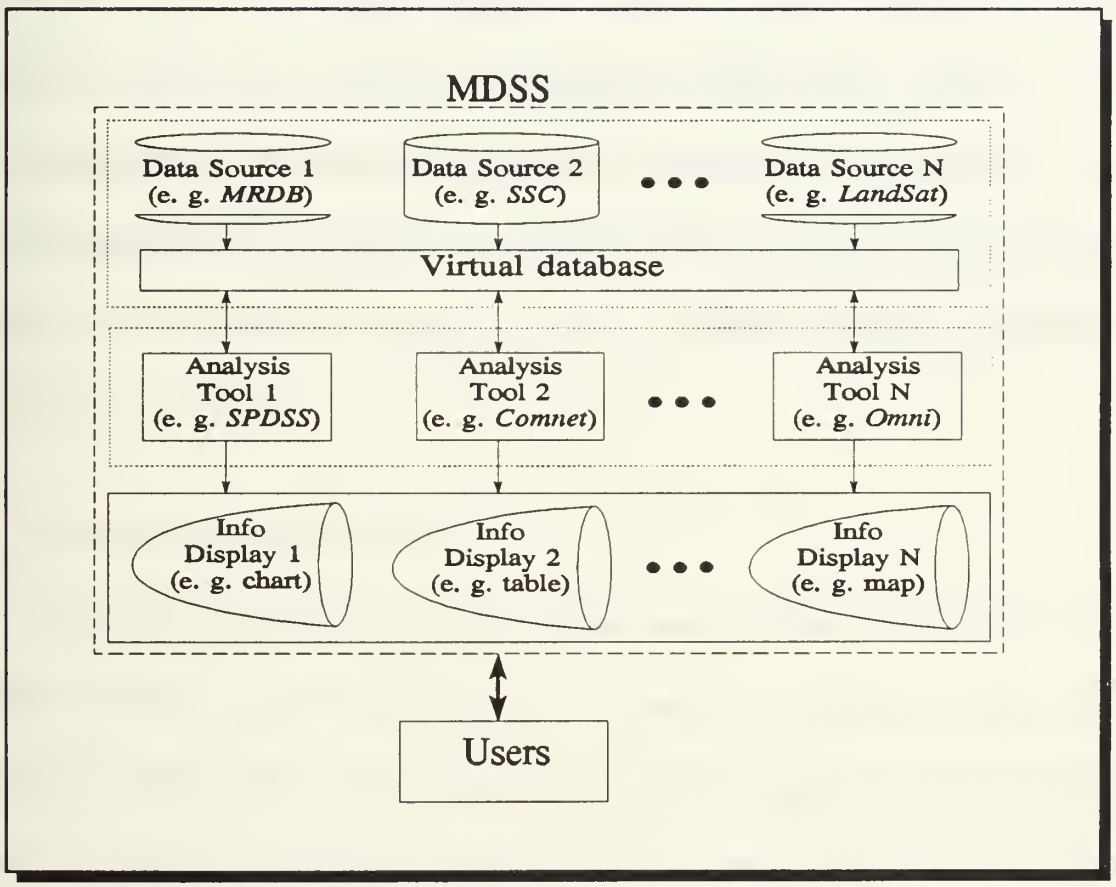

Figure 4 The "sandwich" architecture

A key to implementing the "sandwich" architecture is development of protocols for component tools that allow the MDSS to supply input data and obtain data output, circumventing the tool's resident data sources and output displays, in order to preserve the need for common sets of displays and data.[5] Adoption of *expandability standards*, described on page 12, by the MILSATCOM management community would ensure that new stand-alone tools developed in the future would comply with the protocols necessary to "plug-in" to the MDSS.

B. A MDSS FUNCTIONAL ARCHITECTURE

We suggest adoption of the "sandwich" architecture for the reasons outlined above. From now on, we will direct our study to one component of that architecture, the user interface.

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[5] The concept of using a *virtual database* (Figure 4) to integrate heterogenous databases was described by Kamel (1992).

V. MDSS GRAPHICAL USER INTERFACE (GUI) DESIGN

To most computer users, the system interface *is* the system itself. Therefore, GUI requirements identified in Chapter IV must be translated into a set of input/output formats that the user can easily recognize, identify with his tasks, and engage in a "natural" man-machine dialogue. Experience documented in the DSS literature suggests that special attention must be given in designing the user interface to ensure that the DSS will be accepted by the user.

In this chapter, we use an interface design procedure consisting of six steps. The procedure eventually led to the creation of a MDSS interface prototype. The intention of our interface prototype is to offer the user a first appreciation of the potential of the MDSS.

A. DESIGN ASSUMPTIONS

We attempt to capitalize, to the greatest extent possible, on the existence of MILSATCOM management tools. Not only should the investment in previously developed MDSS-related tools be preserved, but also the proprietorship of MDSS components should be protected. However, as discussed in Chapter IV, the MDSS must still be able to integrate future stand-alone tools in its environment.

Furthermore, a well designed and tested user interface with context-sensitive and hypertext-based help facilities backed up by an on-line tutorial and thorough documentation will require little, if any, user training. It is believed that a demonstration would be sufficient to motivate the users to appreciate the usefulness of the MDSS while avoiding excessive training costs.

B. THE INTERFACE DESIGN PROCESS

Bui (1987) advocates the use of a six-step procedure to implement a user-oriented man-machine interface. These six steps are briefly described in Table 9.

Table 9 SIX STEPS IN USER INTERFACE DEVELOPMENT

Interface Development Step	Description
1. Establish interface conventions	Input and output formats should be standardized and clearly specified to facilitate user interaction and reduce misunderstandings and visual overload.
2. Simulate and test a decision support session	Using sample formats developed on paper, decision scenarios should be simulated for potential users in order to identify interaction difficulties, missing inputs/ outputs, and errors.
3. Select development tools	Hardware, software, and programming techniques should be selected on the basis of the complexity of displays and supporting model calculations.
4. Perform tradeoff analysis	Alternative interface designs must be evaluated on the basis of cost/benefit ratios.
5. Test and refine the design	Usability tests with potential system users should be conducted to incrementally improve the design.
6. Establish implementation procedures	Provision for user orientation and training should made.

Since this research focuses on providing a demonstration of concept of an effective DSS interface for MILSATCOM management, we will concentrate on the first two steps. It is recommended that the selected contractor for the development of the MDSS follow the rest of the procedure.

C. IMPLEMENTING THE MDSS INTERFACE PROTOTYPE

1. Establish Interface Conventions

We adopted the window design convention established by Microsoft (1990). We assume that the Microsoft *Windows* is generic enough so that the key ideas proposed in our interface prototype can be replicated across operating system platforms. The basic window conventions are:

- Title bars
- Menu bars
- Control menu
- Minimize and maximize boxes
- Horizontal and vertical scroll bars
- Window borders
- Menus
- Dialog boxes

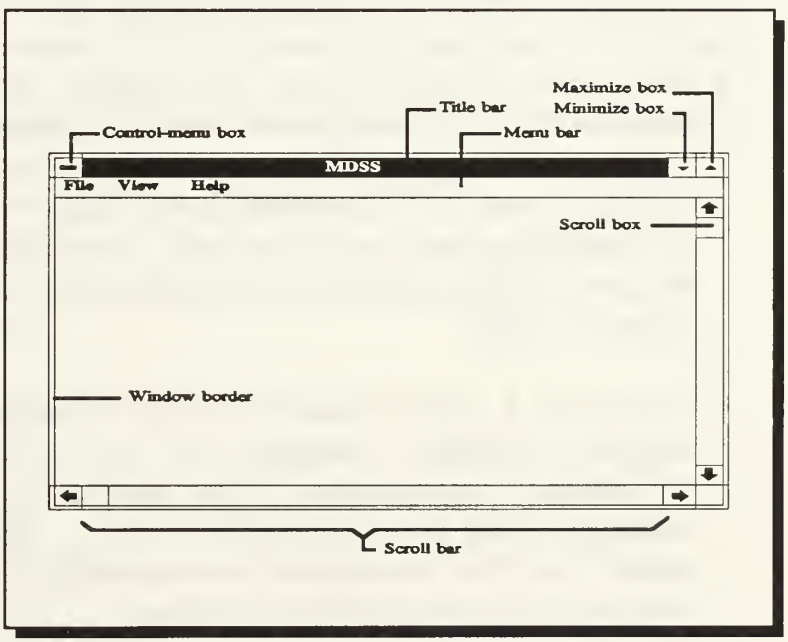


Figure 5 Window Design Conventions

The following constraints associated with the display conventions are suggested below:

- To reduce MDSS user visual overload, the principle of displaying no more than seven, plus or minus two, chunks of information at a time will be used. For example, when more than one window is open on the screen, menu and button bars will only be displayed in the active window.

- When the cursor is pointed at an item on the menu bar, a brief explanation for that item will appear on the title bar of the same window.

- Windows will be dynamically linked so that MDSS users may conduct sensitivity analysis across applications.

- Frequently used menu items will be assigned to function keys. Pull-down menus will identify the function key associated with a menu item.

- Pressing <ESC> in a menu returns the user to the next higher level menu.

- Dark screen backgrounds are more suitable for use in well-lighted rooms. Provide multiple perspectives when displaying complex structures and processes. Use color to enhance black and white information; design the display to work well first in black and white. Viewers see a spectral order as a natural one and would select red, green, and blue as intuitive choices for the front, middle, and back, respectively, when viewing a multi-layer display (Marcus, 1990).

- Users have a natural desire to migrate from menus and Q/A interfaces to command language interface as they become more experienced. Accordingly, a combination of the menu and Q/A interface with command language yields best results (Bui, 1987). Sprague and Carlson (1982) provide excellent illustrations comparing Q/A process-oriented input with dialogue box process-independent input.

- Screen manipulation controls available to the user should support all stages of decision-making, including intelligence, design, and choice activities (Sprague and Carlson, 1982).

2. Simulate Decision Session

As described on page 15, the use of both process-oriented and process-independent controls is suggested. The process-oriented controls try to replicate to the user the most typical process in managing MILSATCOM requirements and resources. The design behind the process-independent controls is to let the user choose the tools made available to him in order to develop his own decision making framework.

a. Identify representative decision tasks

To implement the process-oriented interface, it is necessary to identify representative decision tasks. From Table 3, our demonstration of concept addressed the following decision problems.

- Capacity apportionment
- Capacity shortfall analysis
- Space operations
- Evaluating new architectures

The sequence of menu selections ("Activities" menu selection), shown in Figure 6, illustrates how the MDSS could support decision making in the following typical task sequence.

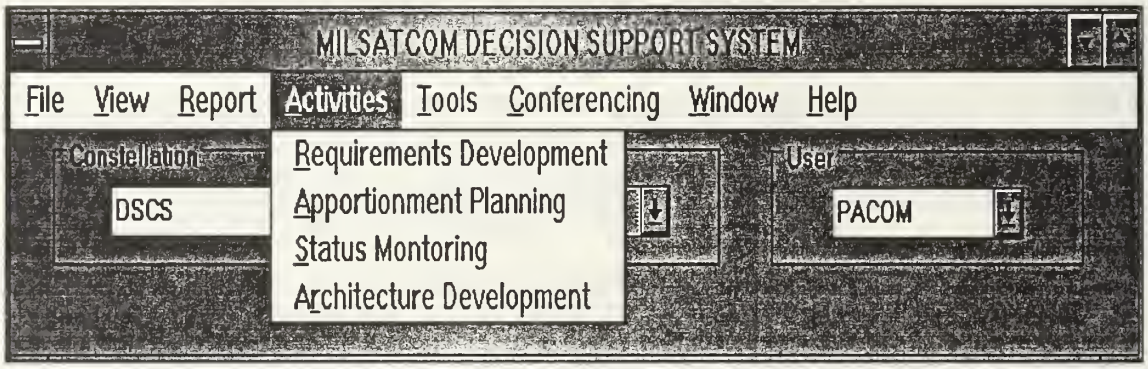


Figure 6 MDSS ACTIVITIES MENU SELECTION

b. Construct interfaces for all possible decision scenarios

To implement the process-independent interface, we included a wide variety of data retrieval and analysis tools, with options for a variety of display formats in the "Tools" Menu. Shown in Figure 7, the "Tools" menu selection lets the experienced users record new scripts for addition to the "Activities" menu selection as new commonly occurring decision problems come along.

D. DESIGNING INFORMATION DISPLAYS

The GUI was first sketched using "paper-and-pencil" tools during meetings with USSPACECOM representatives. The pencil sketches were then carefully

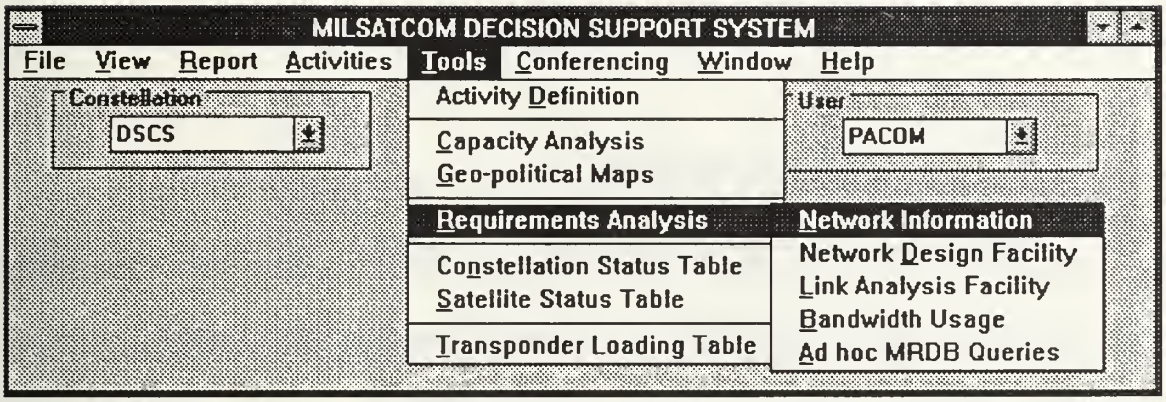


Figure 7 MDSS TOOLS MENU SELECTION

reconciled against Tables 3 and 4 resulting in amendments to both the tables and the sketches. The tables and sketches were next implemented in a limited-function user interface which allowed menu selections to open combinations and sequences of information displays appropriate to a user-specified decision problem. The refined version was coded in a MS-DOS/Windows-based programming language.

The sequencing of the various screens related to supporting the MILSATCOM management is provided in Appendix C.

VI. CONCLUSIONS

A. SUMMARY OF FINDINGS

The purpose of this research was to follow a structured approach to developing an effective graphical user interface as part of the development of a decision support system to help USSPACECOM manage MILSATCOM requirements and resources (MDSS). We reviewed mission-governing documents to analyze information requirements as they pertain to USSPACECOM missions and roles (Chapter II). The information requirements were then transcribed into functional specifications for the MDSS (Chapter III). We were able to identify critical success factors for the MDSS to justify its existence. Given well-proven computerized tools which support some aspects of the MILSATCOM management process, we advocated a "sandwich" architecture for MDSS (Chapter IV). If this architecture is properly implemented, we believe that the investment in existing MILSATCOM management tools can be preserved while ensuring data consistency, maximum exploitation of available data, and allowing for the introduction of new tool components.

Rapid development of graphical user interface technology in recent years has produced a number of display design practices that can improve user

efficiency. The process of designing GUI is a lengthy, tedious, and iterative one. We devised a methodology to implement a graphical user interface for MDSS (Chapter V).

The interface prototype described herein is available to readers, as described in the Preface. The intention of the prototype is to offer the user the "look and feel" of the future MDSS. We assume that interested users can better articulate their needs when operating a "mock-up" of the real thing. The final display will be the results of a series of refinements as the user gains more understanding of the functionalities of the system, and develops a greater level of confidence in using it.

It is hoped that when the "real thing" is actually delivered, it will have the greatest chance of gaining user acceptance, thus contributing to the mission effectiveness of USSPACECOM.

B. ISSUES FOR FURTHER STUDY

There are several analysis tools and data sources required for implementing the MDSS that have not yet been developed that were identified in Tables 5 and 6. One of the most complex but essential tools not yet developed is the assignment model for apportioning system resources, based on communications requirements. We suggest this be a made a high priority for future research.

C. THE NEXT-GENERATION MDSS

We suggest that the MDSS may be developed further in two directions. First, there are a number of Defense organizations besides USSPACECOM having responsibilities related to MILSATCOM management. As described in Chapter II, these organizations must work together, sharing information and reaching mutually agreeable solutions and decisions. Accordingly, the MDSS could be expanded into a *group* decision support system to satisfy that need.

Secondly, the MDSS must be placed into the larger context of managing *all* communications resources in support of *all* communications requirements. To achieve this, the MDSS must be integrated with decision aids used for managing all satellite and terrestrial resources.

APPENDIX A: GLOSSARY

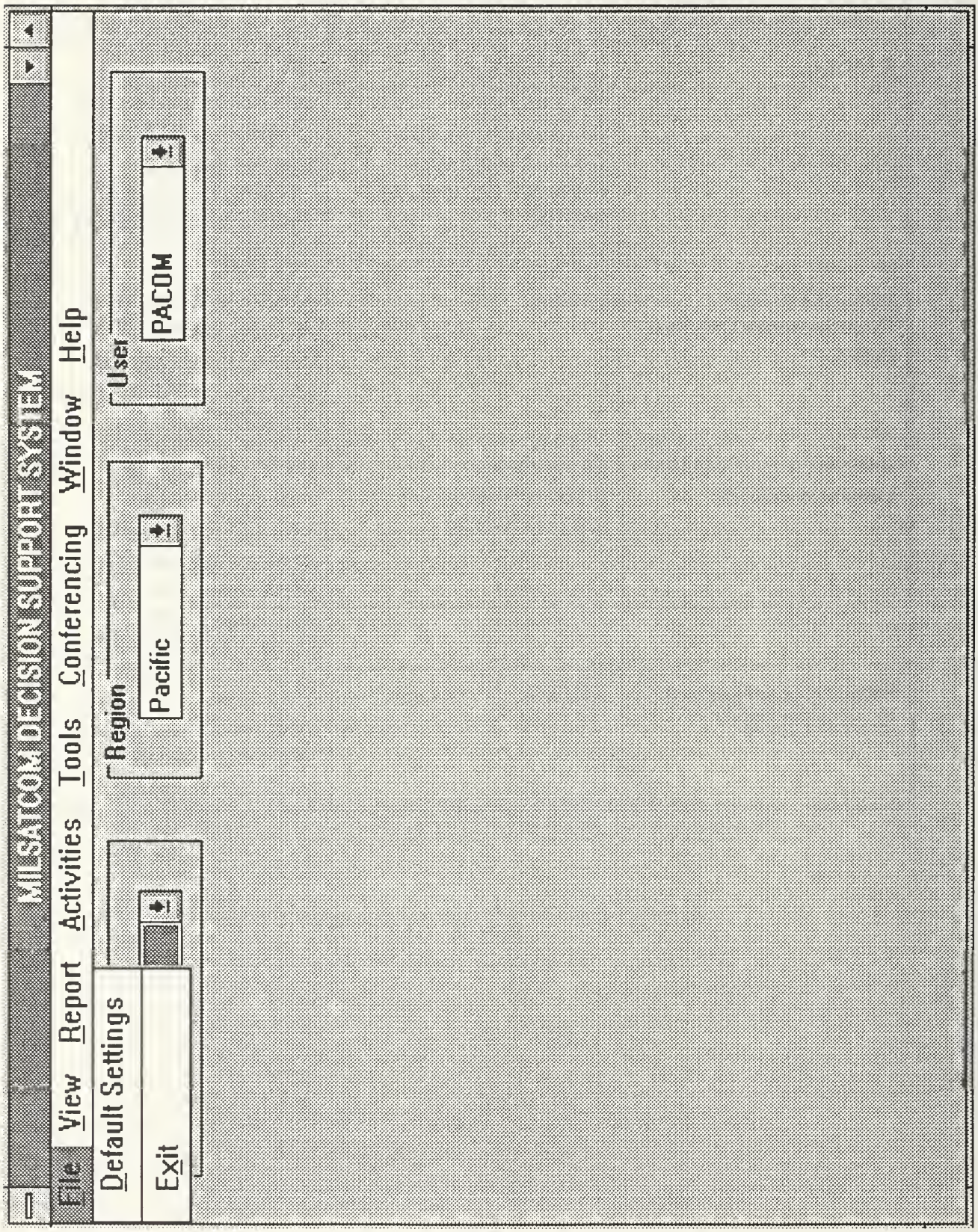
AFSATCOM	Air Force Satellite Communications System
C2	Command and Control
CINC	Commander in Chief
CJCS	Chairman of the Joint Chiefs of Staff
CS	Critical Success Factor
DISA	Defense Information Systems Agency
DMRD	Defense Management Review Document
DSCS	Defense Satellite Communications System
DSS	Decision Support System
EHF	Extremely High Frequency
ESC	Escape
EW	Electronic Warfare
FLTSATCOM	Fleet Satellite Communications System
GUI	Graphical User Interface
ISDB	Integrates Satellite Communications Database
JSCP	Joint Strategic Capabilities Plan
MDSS	Military Satellite Communications Decision Support System
MEB	Marine Expeditionary Brigade
MILSATCOM	Military Satellite Communications
MILSTAR	Military Strategic-Tactical and Relay
MJCS	Memorandum for the Joint Chiefs of Staff
MRDB	Military Satellite Communications Requirements Database
MSO	Military Satellite Communications Office
NCA	National Command Authorities
NCS	National Communications System
NMSD	National Military Strategy Document
POM	Program Objective Memorandum
ROMC	Representations, Operations, Memory Aids, and Controls
RYG	Red, Yellow, Green (referring to not mission capable, partially mission capable, and fully mission capable, respectively)
SATCOM	Satellite Communications
STRATCOM	U. S. Strategic Command
USC	United States Code
USSPACECOM	U. S. Space Command
Wx	Weather

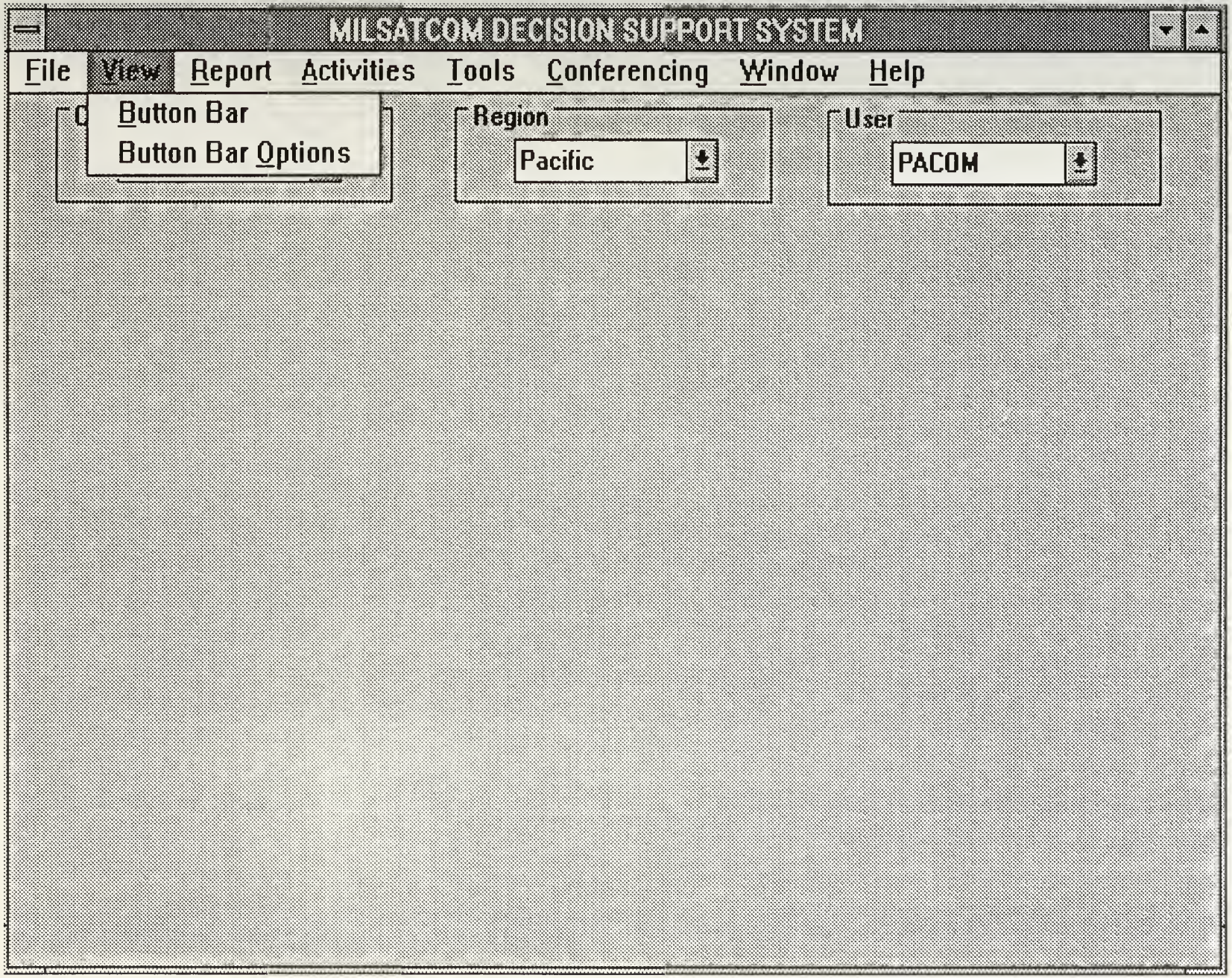
APPENDIX B: MILSATCOM MANAGEMENT TOOLS

MILSATCOM Management Tool	Source	Description
Omni	Autometric 1330 Inverness, Ste 325 Colorado Springs, CO 80910	Used for a wide variety of mission and satellite planning tasks. Combines data analysis with 2-D and 3-D graphics allowing users to simultaneously generate data and interactively create and control multiple views of animated visual simulations.
Commercial Network Exploration Tool (COMNET)	Aerospace Corp P.O. Box 92957 Los Angeles, CA 90009-2957	Developed for NCS use in identifying potential communications assets.
Satellite Coverage Model (SCM)	ARINC Research Corp. 11770 Warner Ave., Ste 210, Fountain Valley, CA 92708	SCM models satellite constellations by plotting coverage regions, satellite ground traces, antenna footprints, and satellite azimuth/elevation.
Satellite Planning Decision Support System (SPDSS)	ARINC	SPDSS evaluates UHF SATCOM networks to generate alternative constellation configuration options for satellite repositioning.

MILSATCOM Management Tool	Source	Description
SATRAK	Teledyne Brown Engineering 1250 Academy Park Loop, Suite 240 Colorado Springs, CO 80910	SATRAK processes orbital element sets to produce numeric and graphic satellite tracking information using the SGP4/SDP4 propagator.
MILSATCOM Requirements Database (MRDB)	ARINC	MRDB contains user requirements for SATCOM. Obtains requirements data from the ISDB.
Integrated SATCOM Database (ISDB)	DISA (MSO) DSN 496-1823 (703) 696-1823	ISDB contains users requirements for SATCOM. Obtains requirement data from users based on validation by the MILSATCOM Panel.
Satellite Management System (SMS)	ARINC	SMS is used by UHF satellite control centers to allocate and control satellite transponders.

APPENDIX C: MDSS USER INTERFACE DISPLAYS

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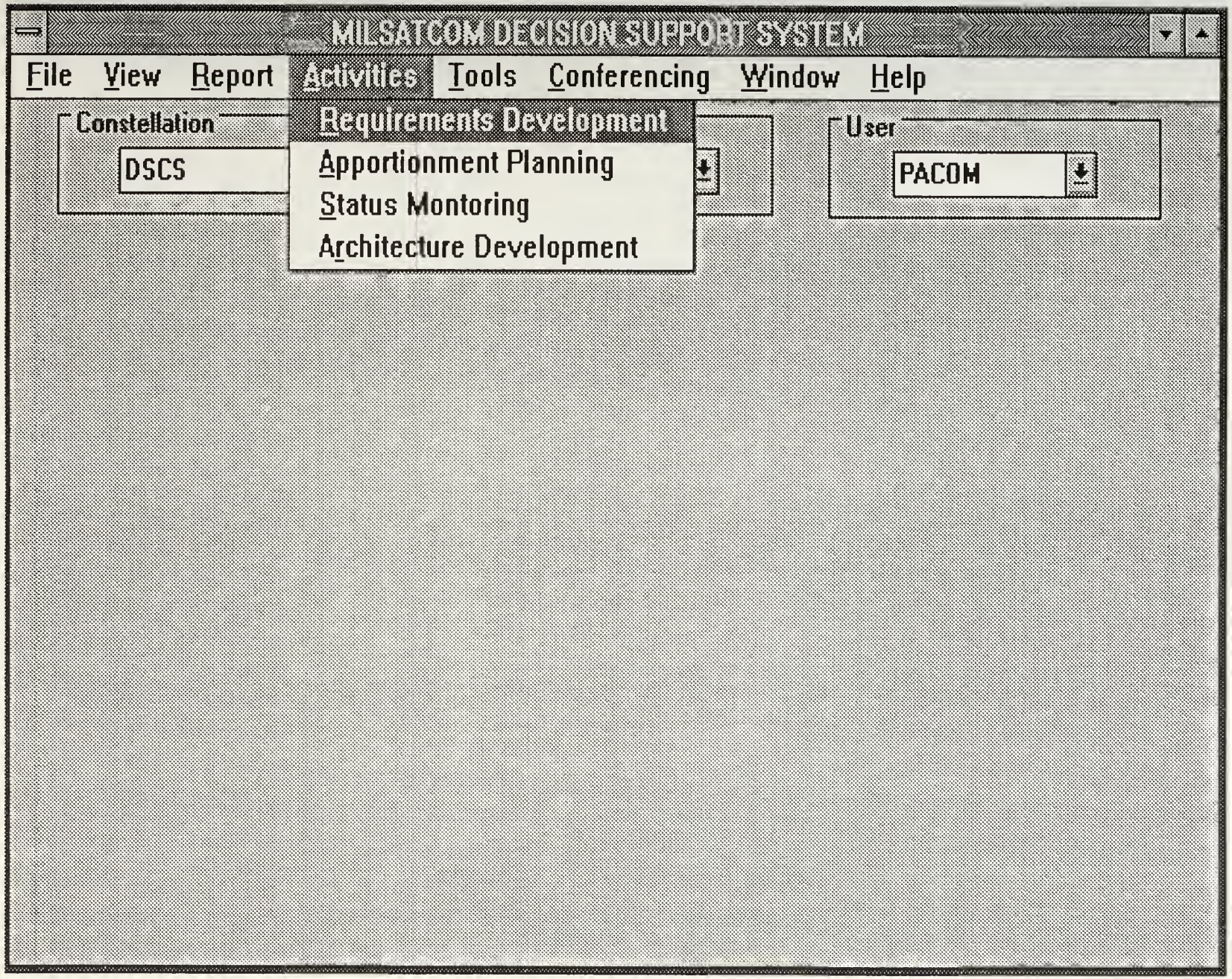
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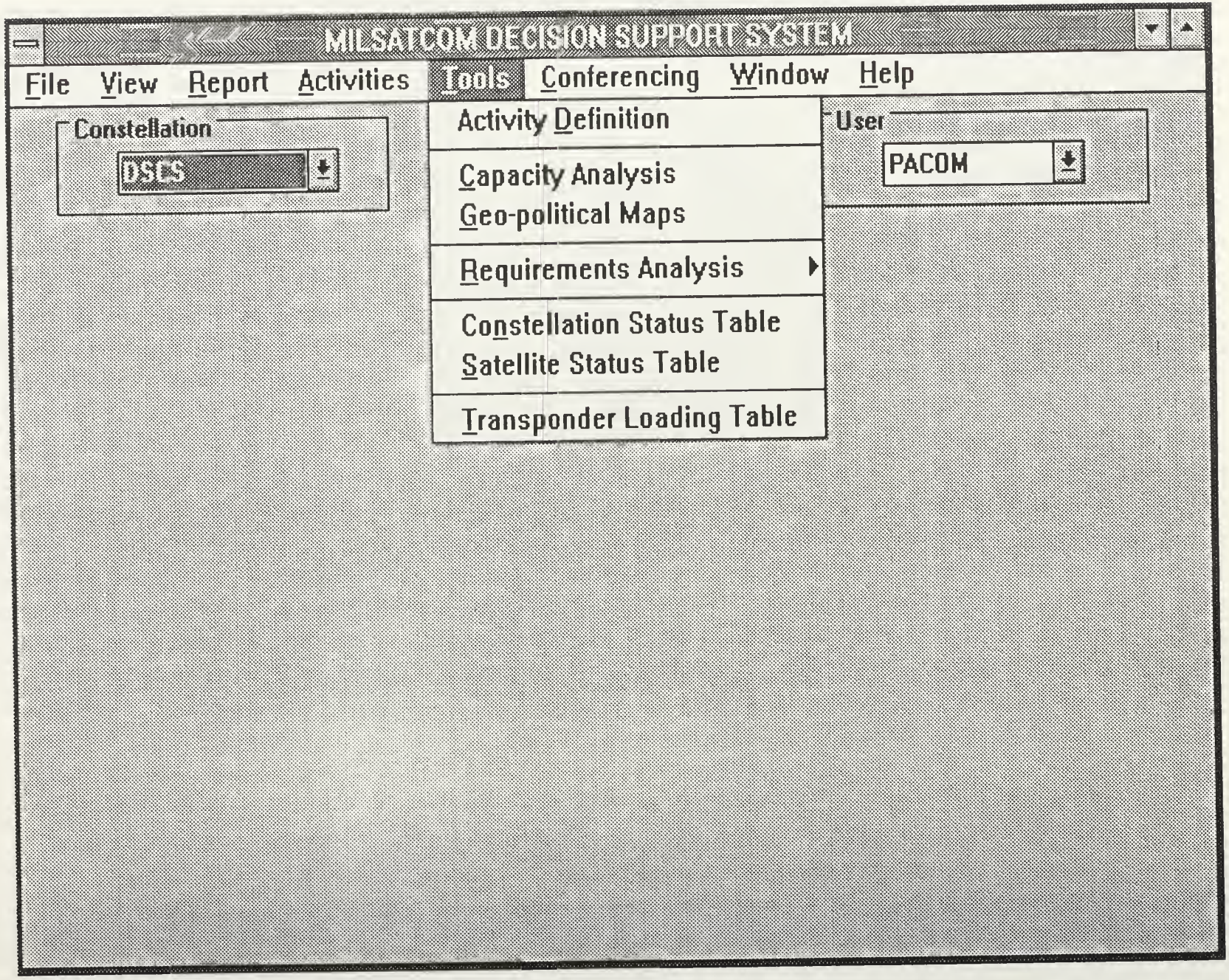
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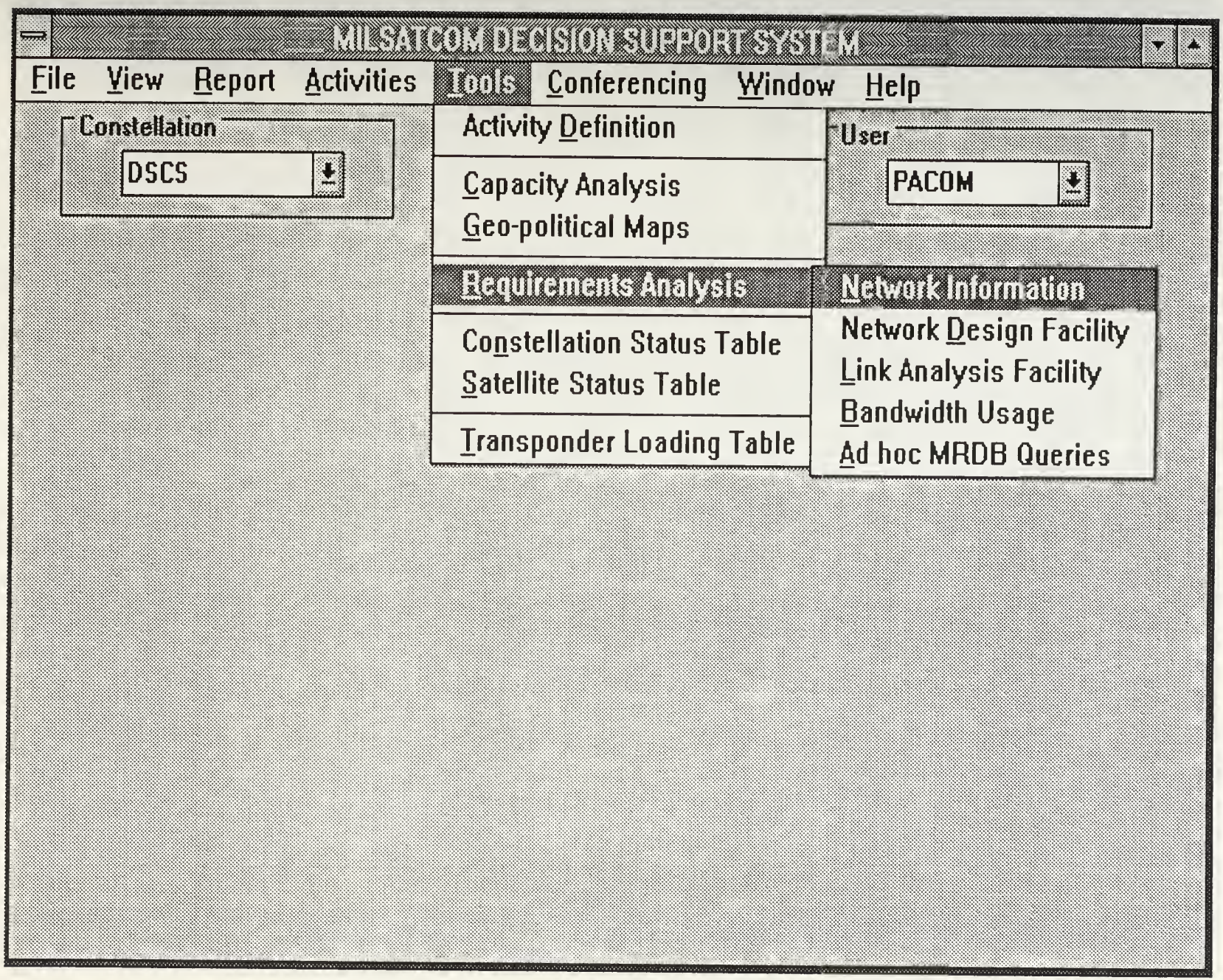
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Geo-political Maps
Requirements Analysis
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Satellite Status Table
Transponder Loading Table
Network Information
Network Design Facility
Link Analysis Facility
Bandwidth Usage
Ad hoc MRDB Queries

MILSATCOM DECISION SUPPORT SYSTEM
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Regio
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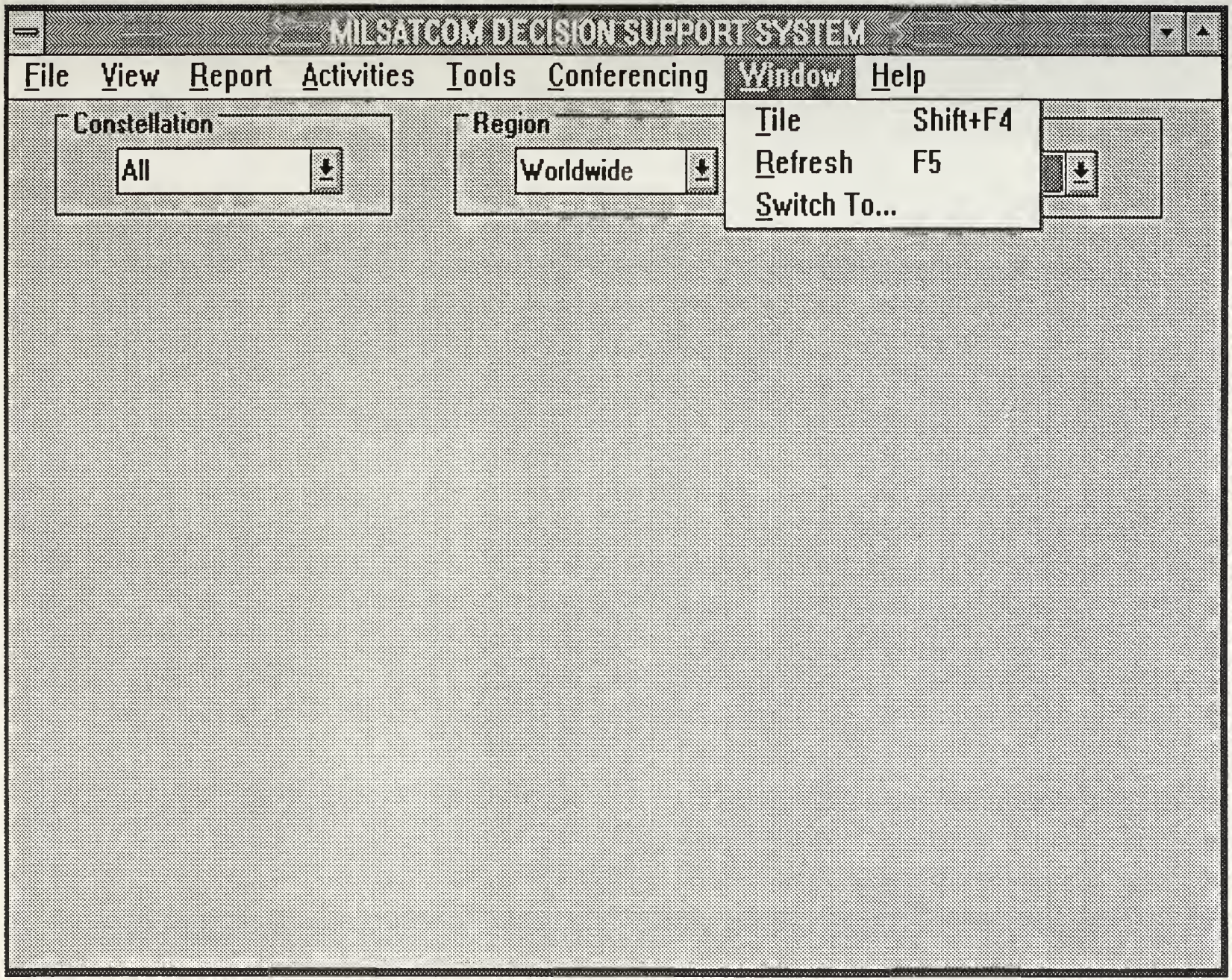
Host Remote Users
Internet Access
LAN Access
User
PACOM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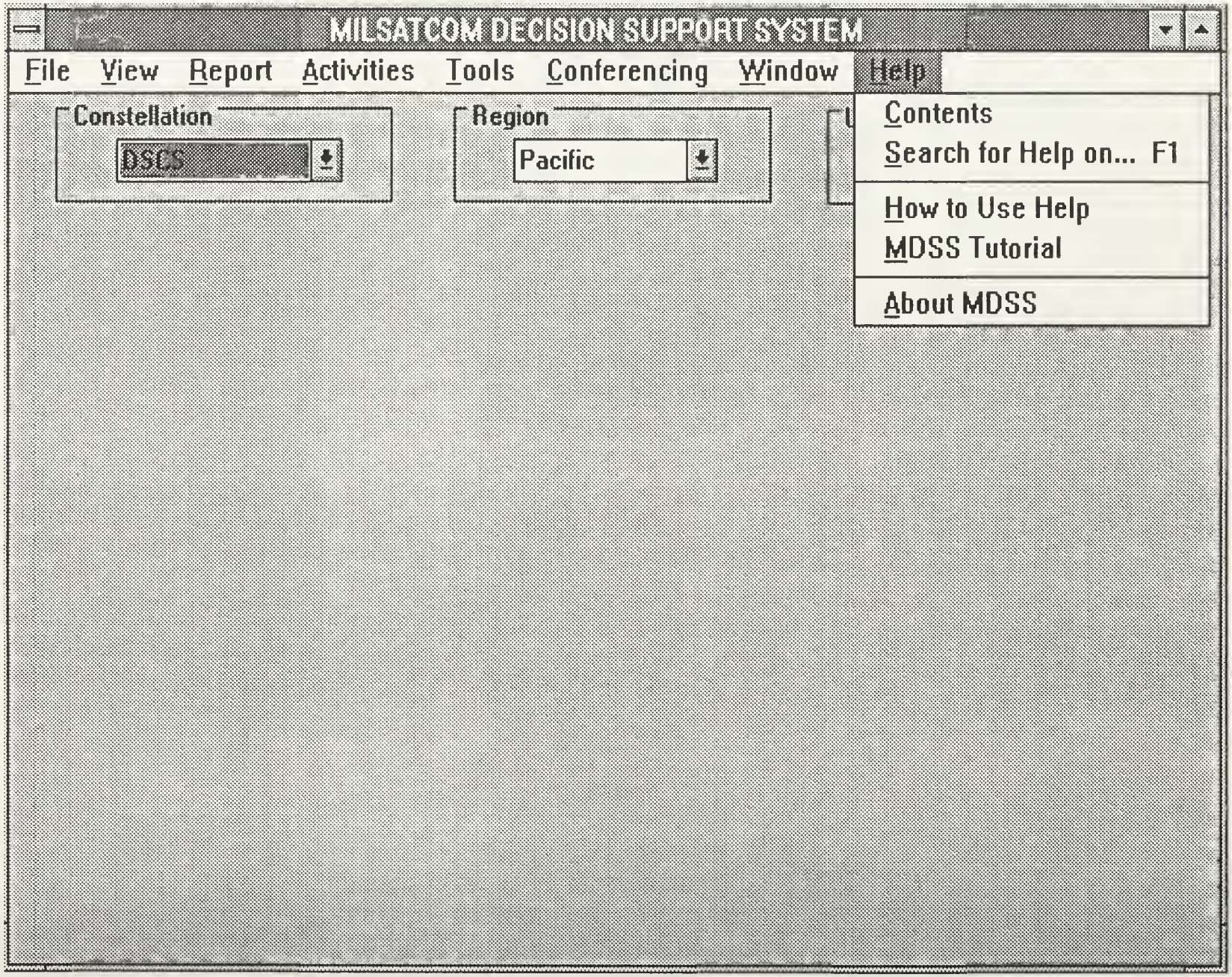
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How to Use Help
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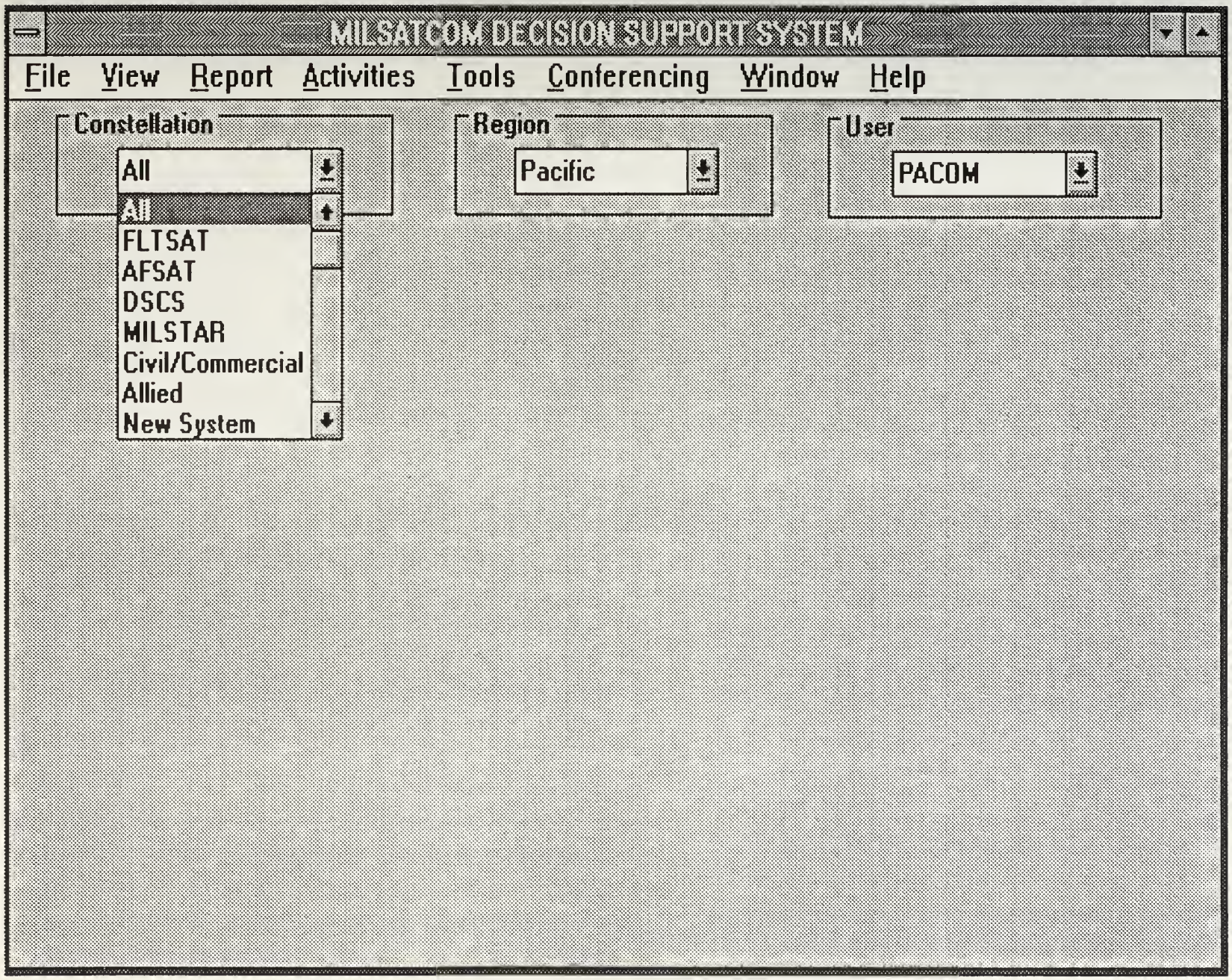
About MDSS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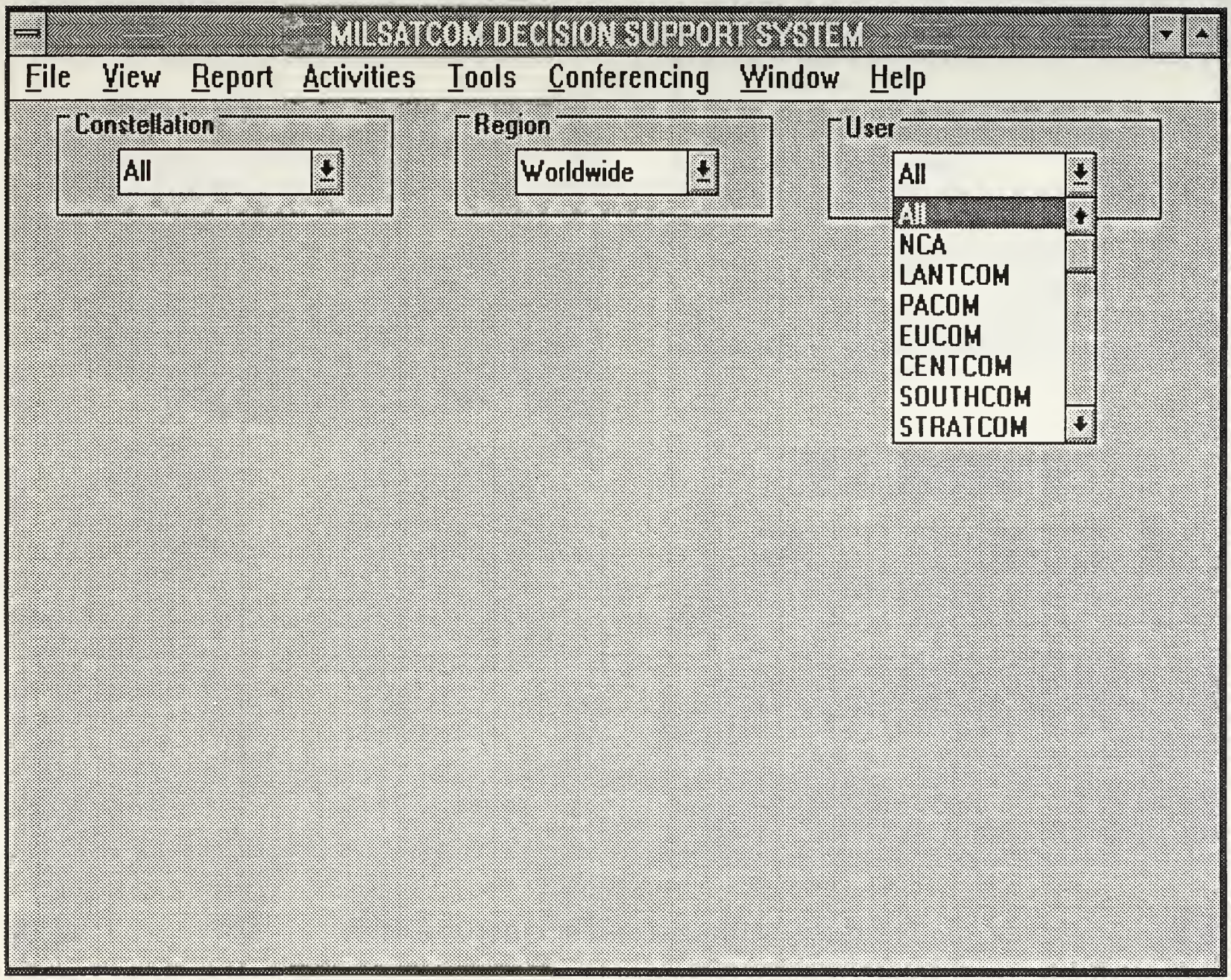
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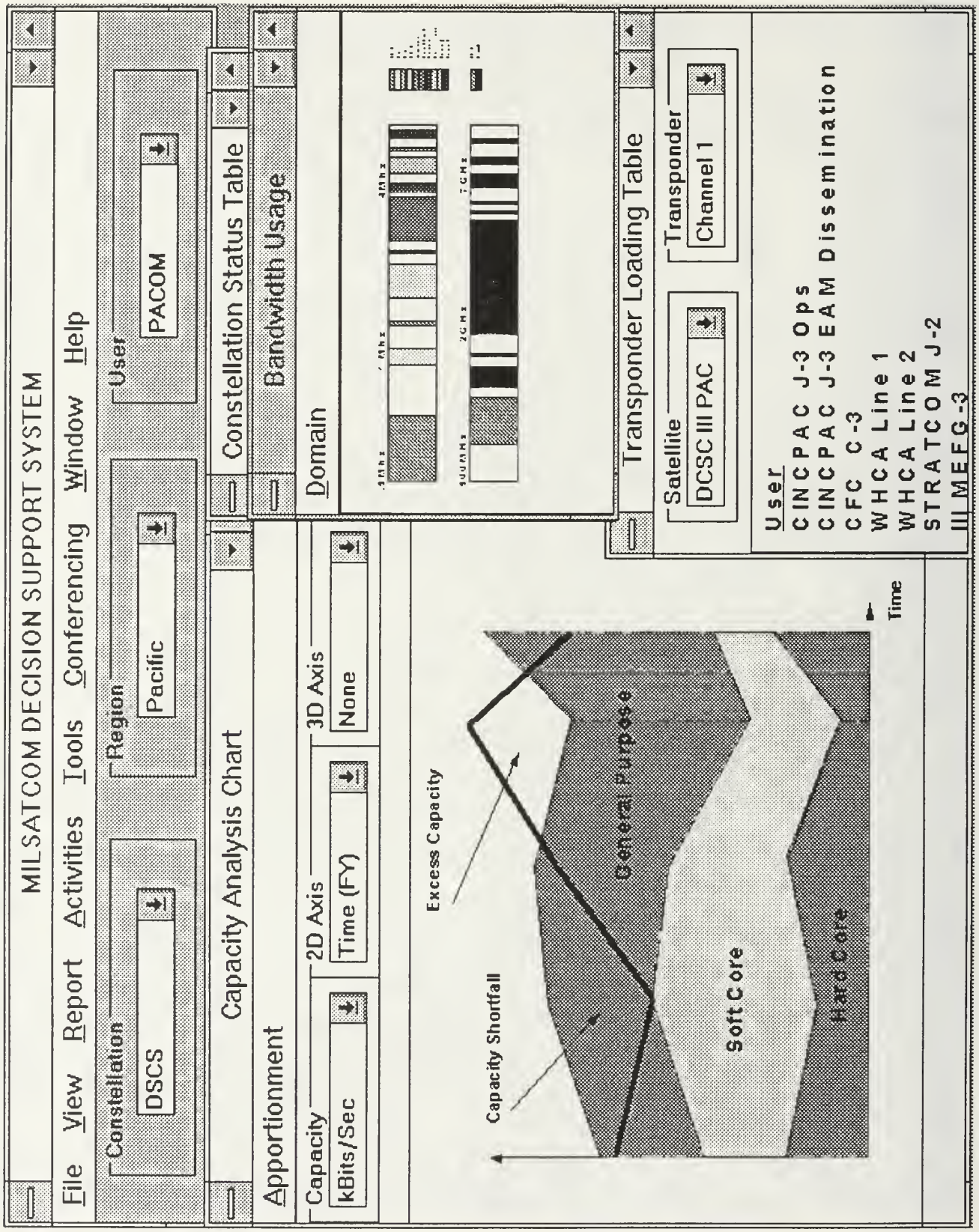
CENTCOM
SOUTHCOM
STRATCOM

Apportionment Planning Activity



MILSATCOM DECISION SUPPORT SYSTEM
File View Report Activities Tools Conferencing Window Help
Constellation
DSCS
Region
Pacific
User
PACOM
Network Diagram
View
Network
CINCPAC Command Net
Network Building Facility
CINC
PACOM
Op Plan
5000
Link Analysis Facility
Earth Station Parameters
Location of E.S. #1: District of Columbia
Latitude (1/2): 38.9
Longitude (1/2): -77.1
Antenna Diameter: 9.0
Antenna Tx Gain: 53.2
Antenna Rx Gain: 49.7
Data Rate (Mbps): 1.554
Rx Sys Noise Temp: 100.0
Satellite Pointing:

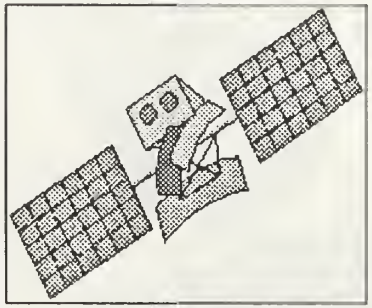
MILSATCOM DECISION SUPPORT SYSTEM

File View Report Activities Tools Conferencing Window Help

Constellation: DSCS | Region: Pacific | User: PACOM

Satellite Status Table

Satellite: DCSC III PAC



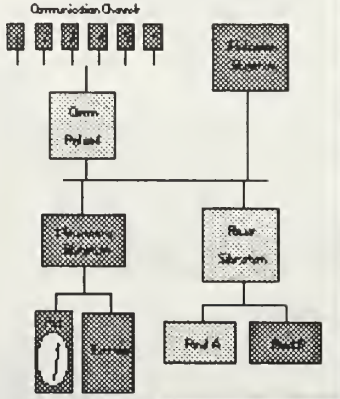
Design Characteristics

Contractor: GE Astro Space Division

Transponders: six SHF 7,900-8,400/7,250-7,750 GHz up/down channels of 50-85 MHz bandwidth using two 40W TWTAs and four 10W SSPAs working through:

- one high gain steerable spot dish
- two 19-beam waveguide lens transmit antennas with beam forming networks to produce selected antenna patterns...

Satellite Subsystem Status



Performance History

Launch: 11 Feb 92 on Atlas MLV-2

Positioning: Geosynchronous at 90W

Chronology:

Date	Event
92213	Arrived at geosynchorbit
92301	Assumed operational mission
93120	...
93213	...
93301	...
93421	...
93430	...
93510	...

Constellation Status Table

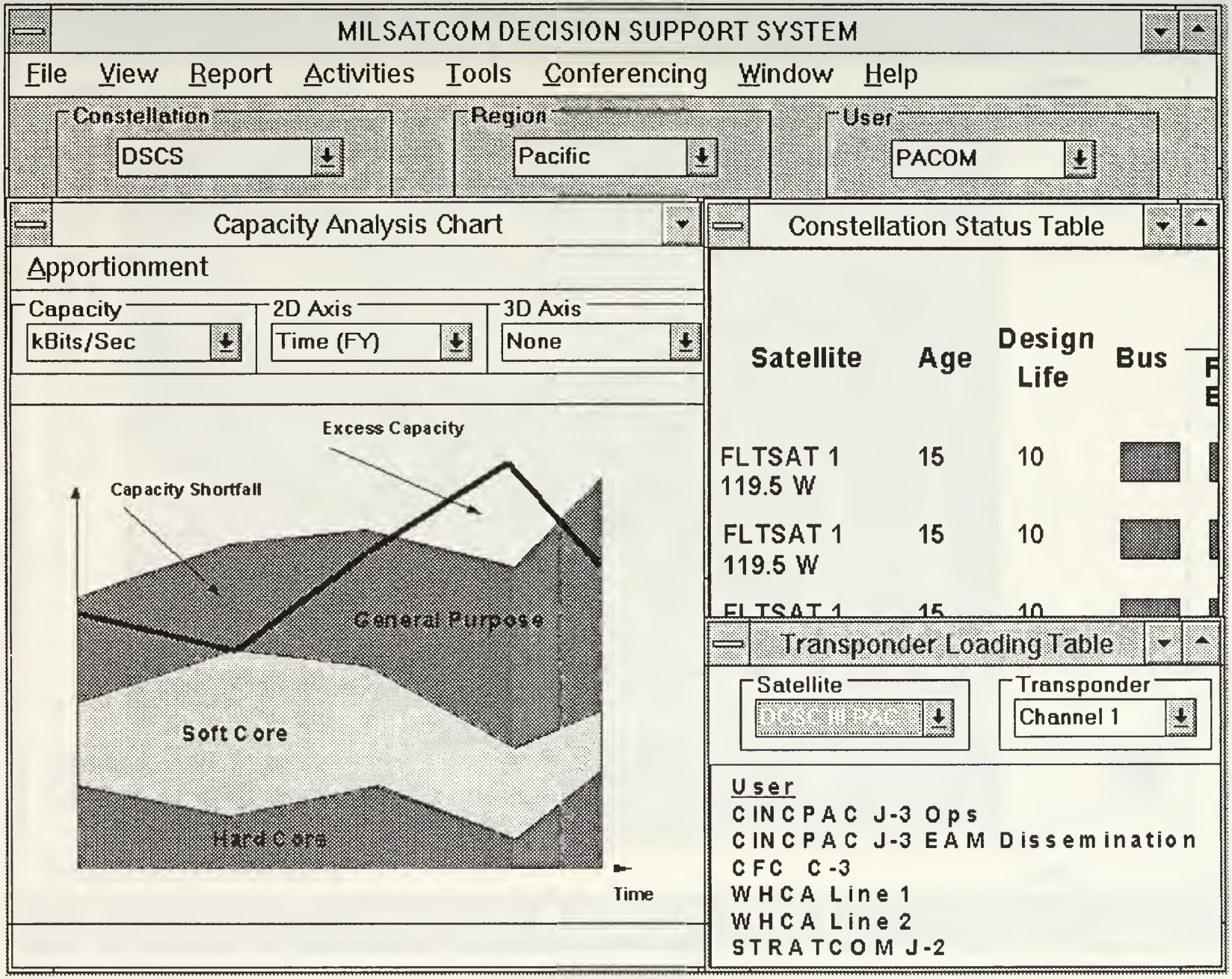
Satellite	Age	Design Life	Bus	Fle BC
FLTSAT 1 119.5 W	15	10		
FLTSAT 1 119.5 W	15	10		
FLTSAT 1	15	10		

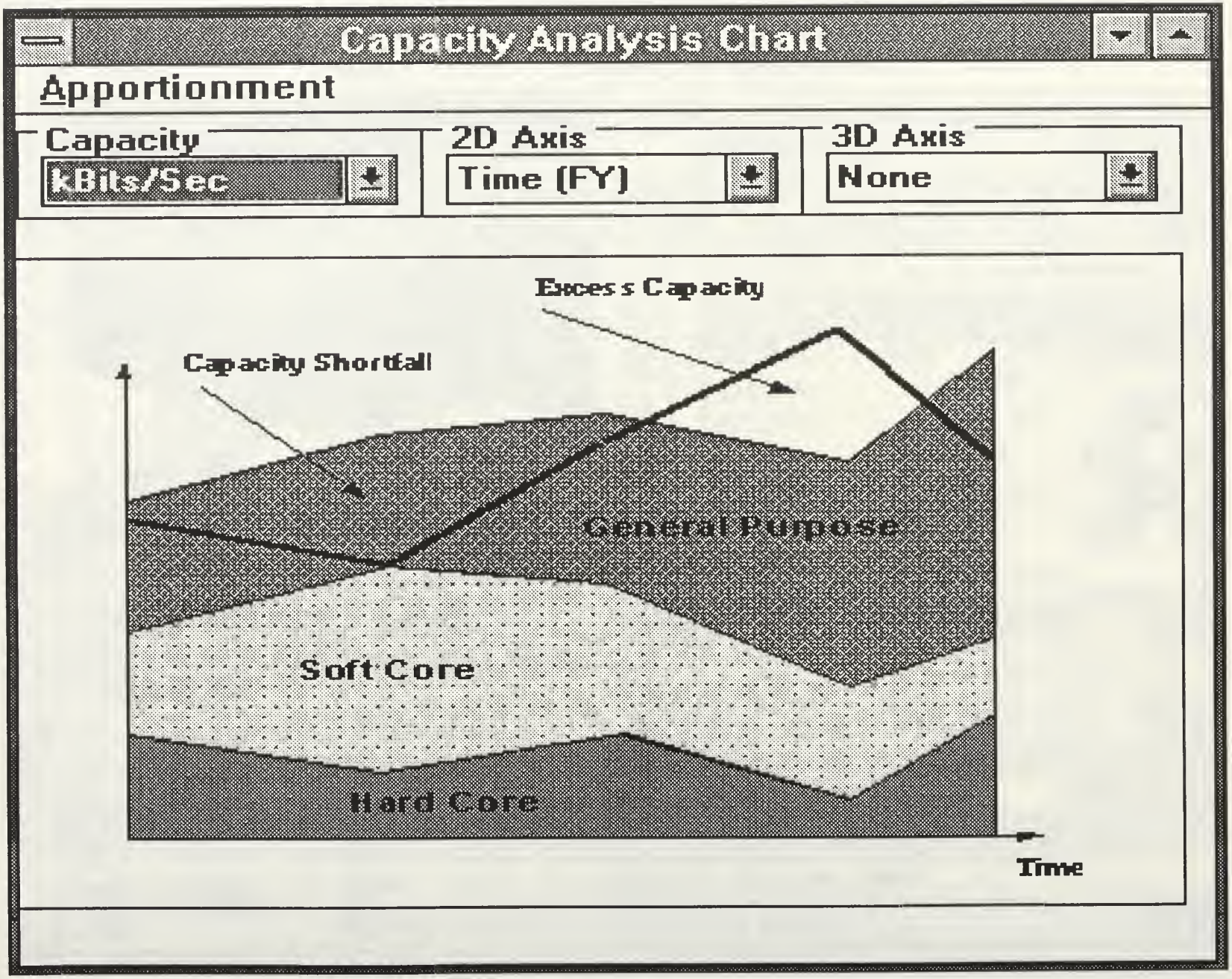
Transponder Loading Table

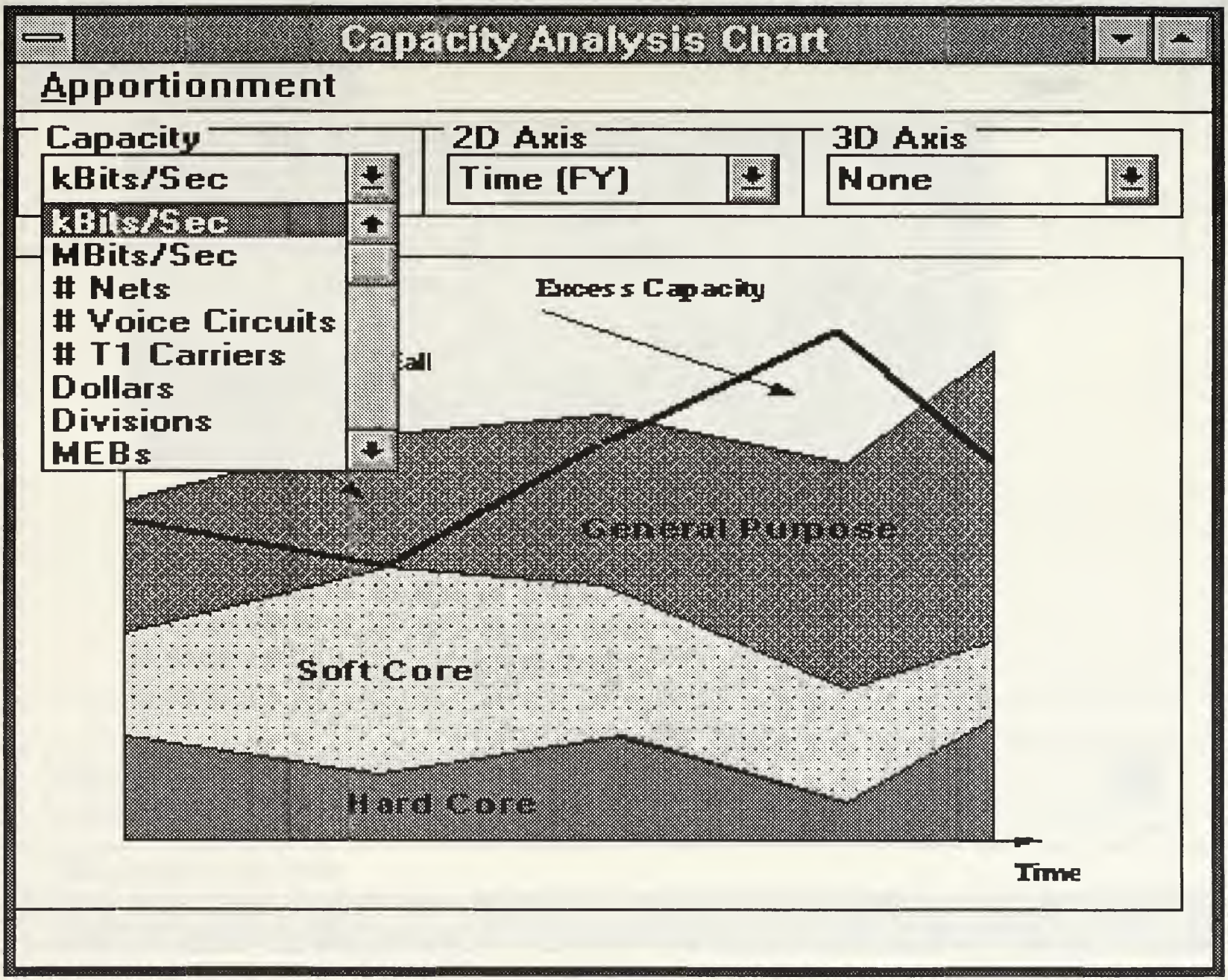
Satellite: DCSC III PAC | Transponder: Channel 1

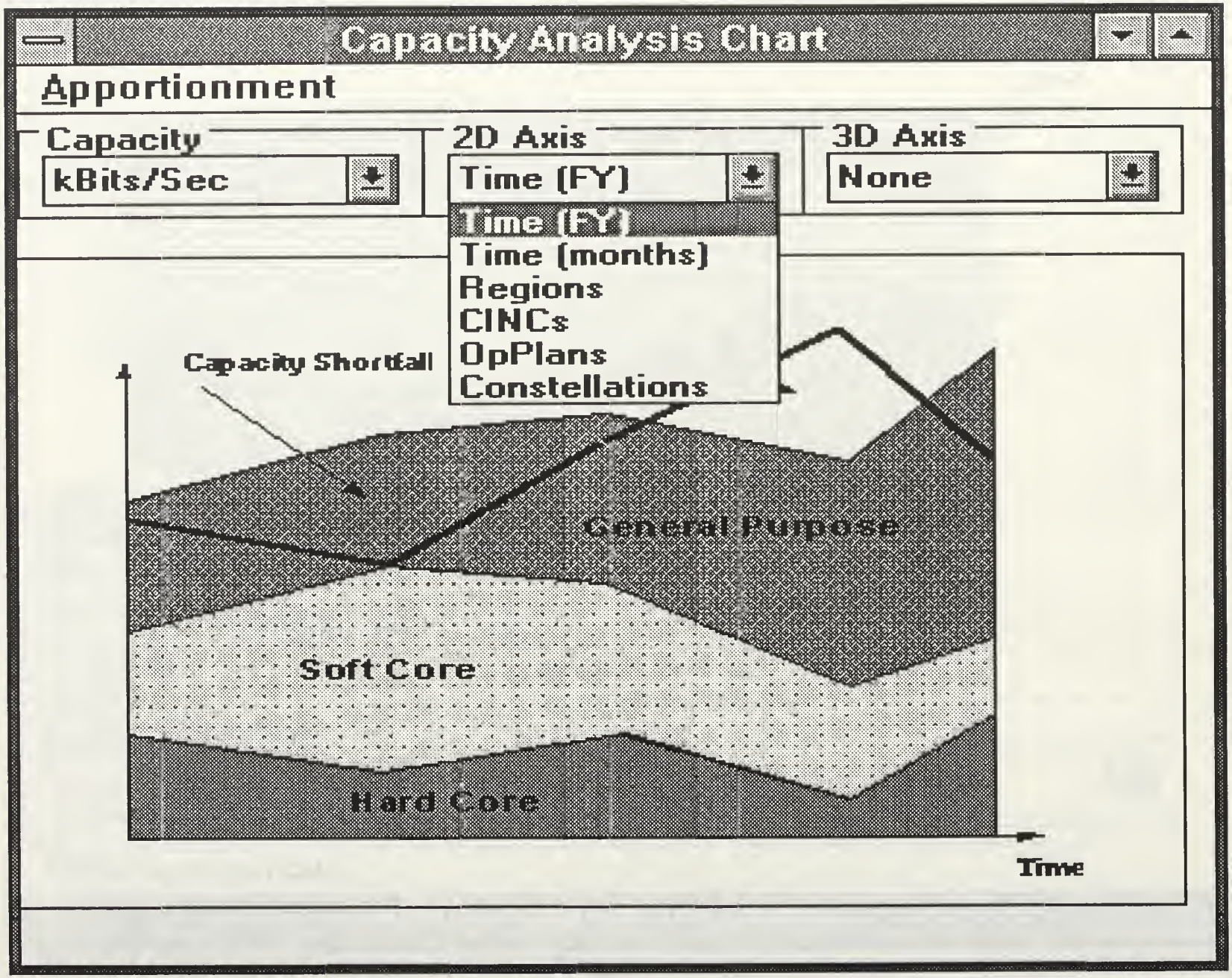
User

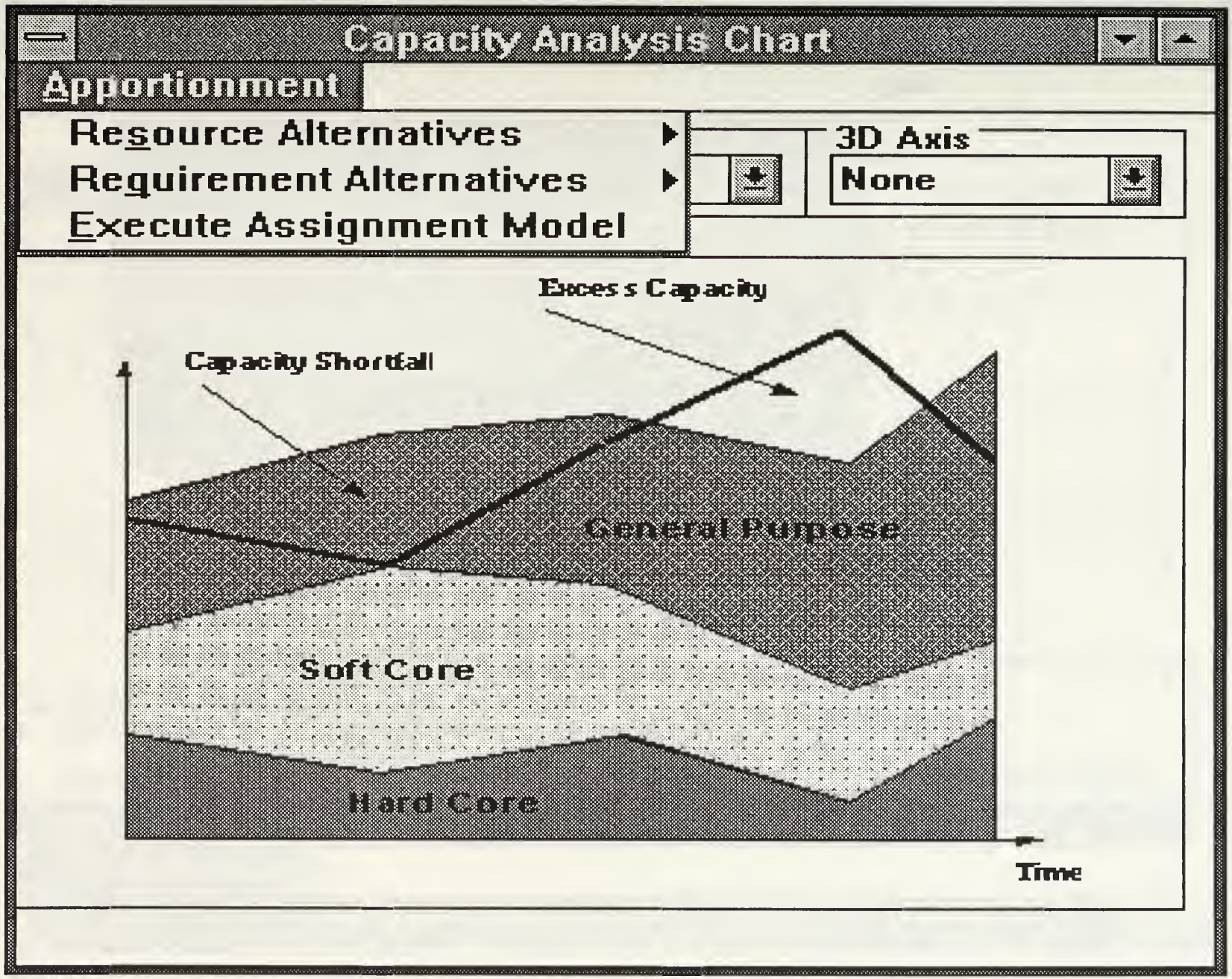
CINCPAC J-3 Ops
CINCPAC J-3 EAM Dissemination
CFC C-3
WHCA Line 1
WHCA Line 2
STRATCOM J-2
USMEFC-3

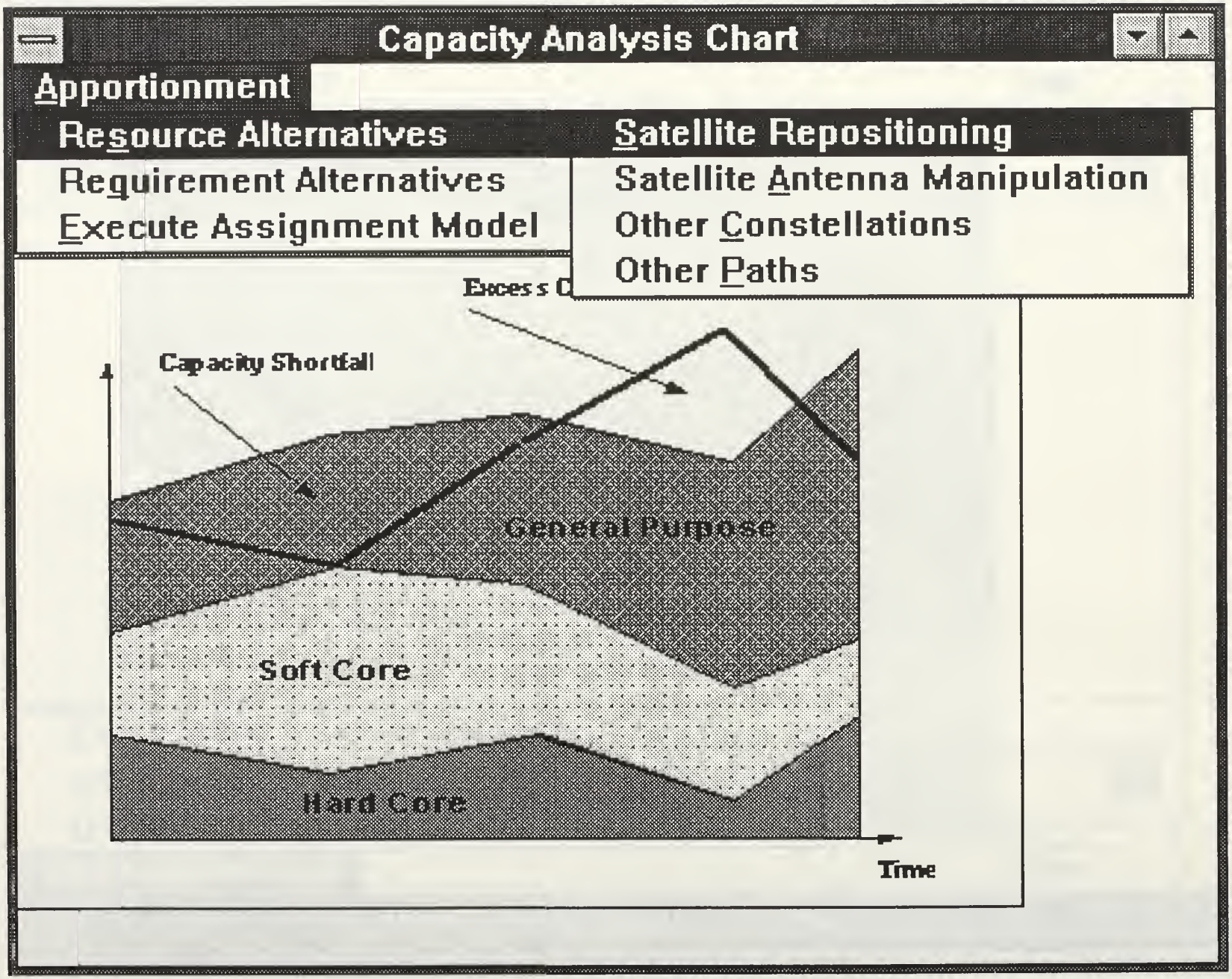

MILSATCOM DECISION SUPPORT SYSTEM
File View Report Activities Tools Conferencing Window Help
Constellation
DSCS
Region
Pacific
User
PACOM
Capacity Analysis Chart
Apportionment
Capacity
kBits/Sec
2D Axis
Time (FY)
3D Axis
None
Excess Capacity
Capacity Shortfall
General Purpose
Soft Core
Hard Core
Time
Constellation Status Table
Satellite
Age
Design Life
Bus
FLTSAT 1 119.5 W
15
10
FLTSAT 1 119.5 W
15
10
Transponder Loading Table
Satellite
Transponder
Channel 1
User
CINCPAC J-3 Ops
CINCPAC J-3 EAM Dissemination
CFC C-3
WHCA Line 1
WHCA Line 2
STRATCOM J-2

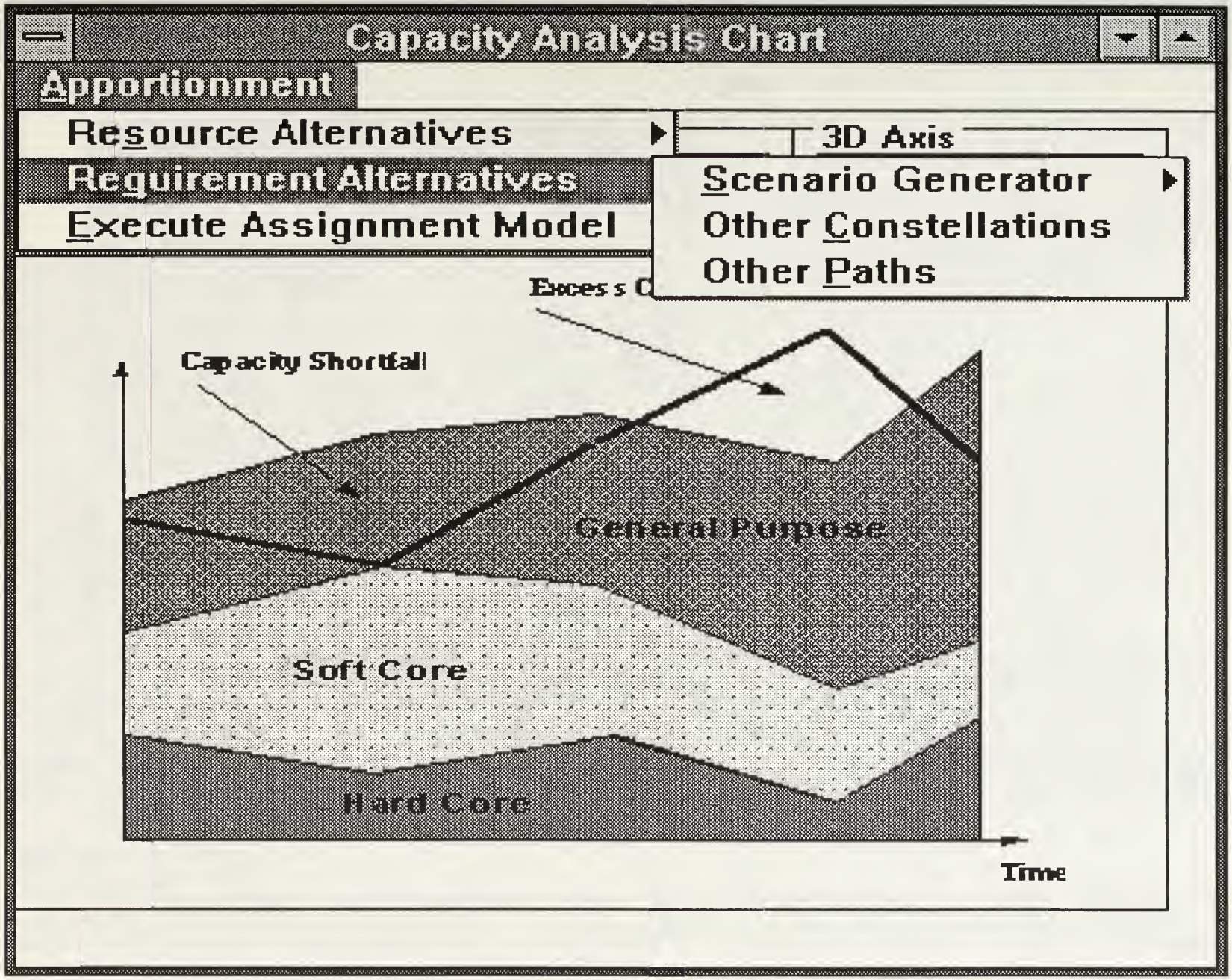

Capacity Analysis Chart
Apportionment
Capacity
kBits/Sec
2D Axis
Time (FY)
3D Axis
None
Excess Capacity
Capacity Shortfall
General Purpose
Soft Core
Hard Core
Time

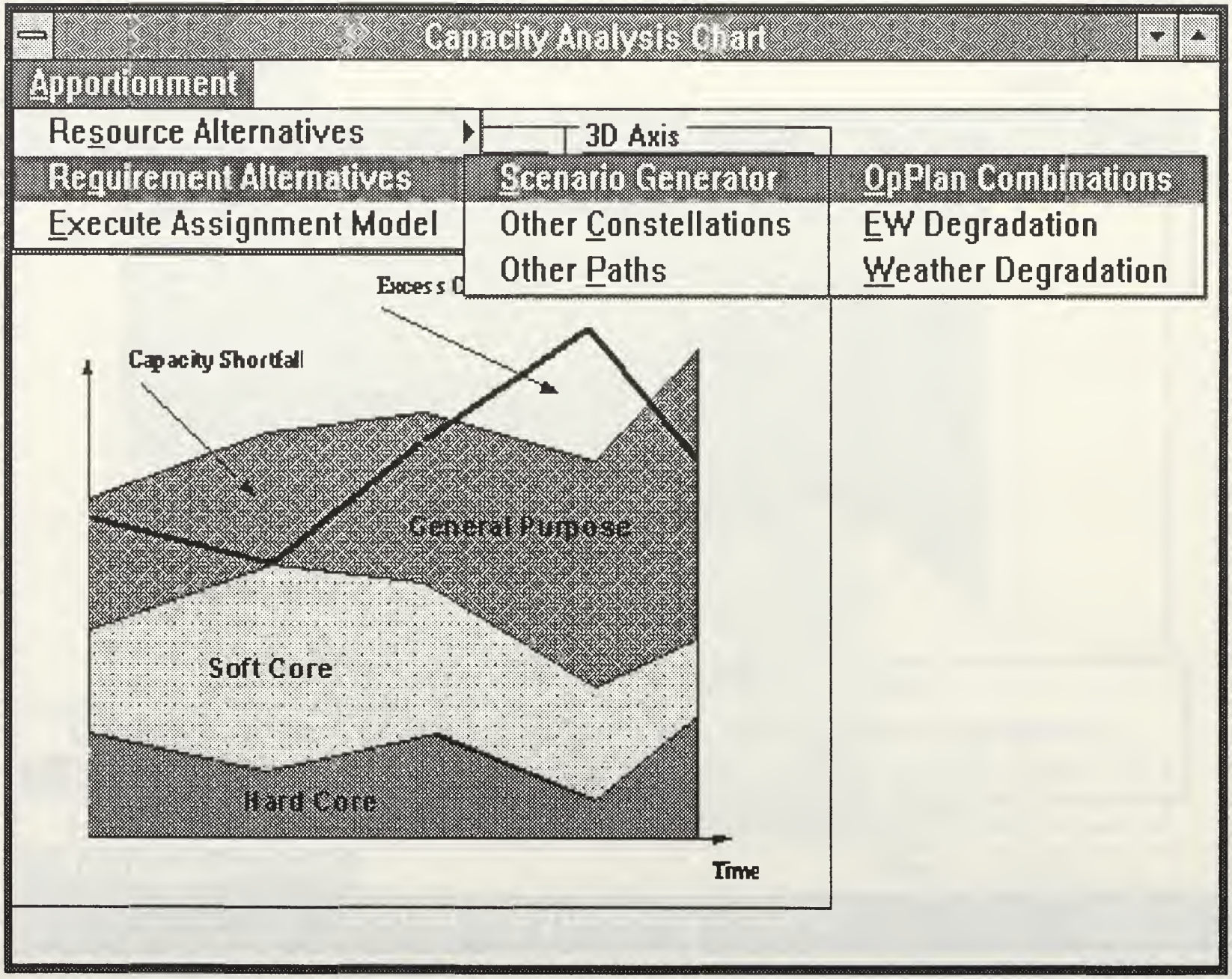

Capacity Analysis Chart
Apportionment
Capacity
kBits/Sec
kBits/Sec
MBits/Sec
Nets
Voice Circuits
T1 Carriers
Dollars
Divisions
MEBs
2D Axis
Time (FY)
3D Axis
None
Excess Capacity
General Purpose
Soft Core
Hard Core
Time


Capacity Analysis Chart
Apportionment
Capacity
kBits/Sec
2D Axis
Time (FY)
Time (FY)
Time (months)
Regions
CINCs
OpPlans
Constellations
3D Axis
None
Capacity Shortfall
General Purpose
Soft Core
Hard Core
Time


Capacity Analysis Chart
Apportionment
Resource Alternatives
Requirement Alternatives
Execute Assignment Model
3D Axis
None
Excess Capacity
Capacity Shortfall
General Purpose
Soft Core
Hard Core
Time


Capacity Analysis Chart
Apportionment
Resource Alternatives
Requirement Alternatives
Execute Assignment Model
Satellite Repositioning
Satellite Antenna Manipulation
Other Constellations
Other Paths
Excess C
Capacity Shortfall
General Purpose
Soft Core
Hard Core
Time


Capacity Analysis Chart
Apportionment
Resource Alternatives
Requirement Alternatives
Execute Assignment Model
3D Axis
Scenario Generator
Other Constellations
Other Paths
Excess C
Capacity Shortfall
General Purpose
Soft Core
Hard Core
Time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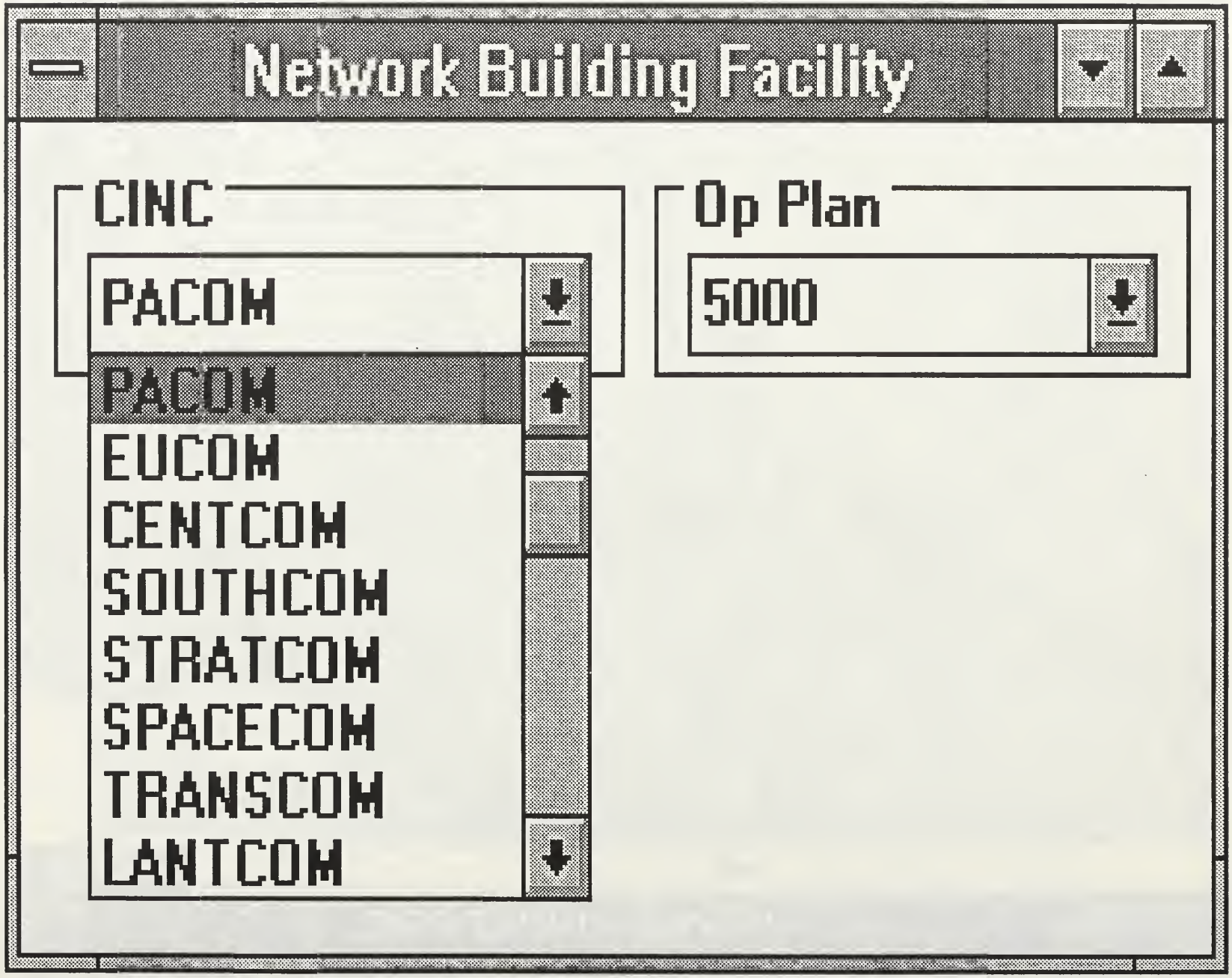
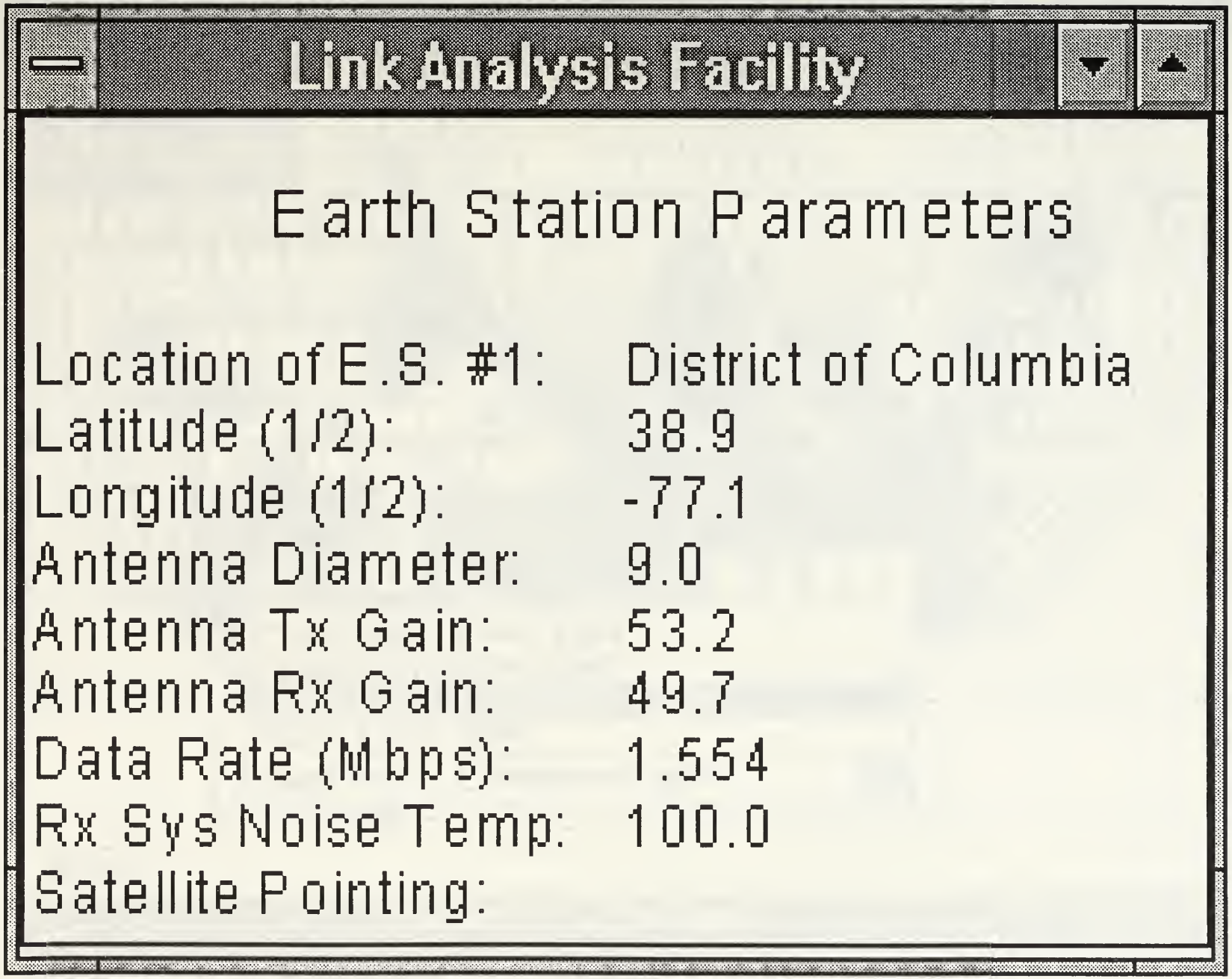
Resource Alternatives
Requirement Alternatives
Execute Assignment Model
3D Axis
Scenario Generator
Other Constellations
Other Paths
OpPlan Combinations
EW Degradation
Weather Degradation
Capacity Shortfall
General Purpose
Soft Core
Hard Core
Time

Geo-Political Maps
View
Zoom
Scroll
Restore


Network Building Facility
CINC
PACOM
PACOM
EUCOM
CENTCOM
SOUTHCOM
STRATCOM
SPACECOM
TRANSCOM
LANTCOM
Op Plan
5000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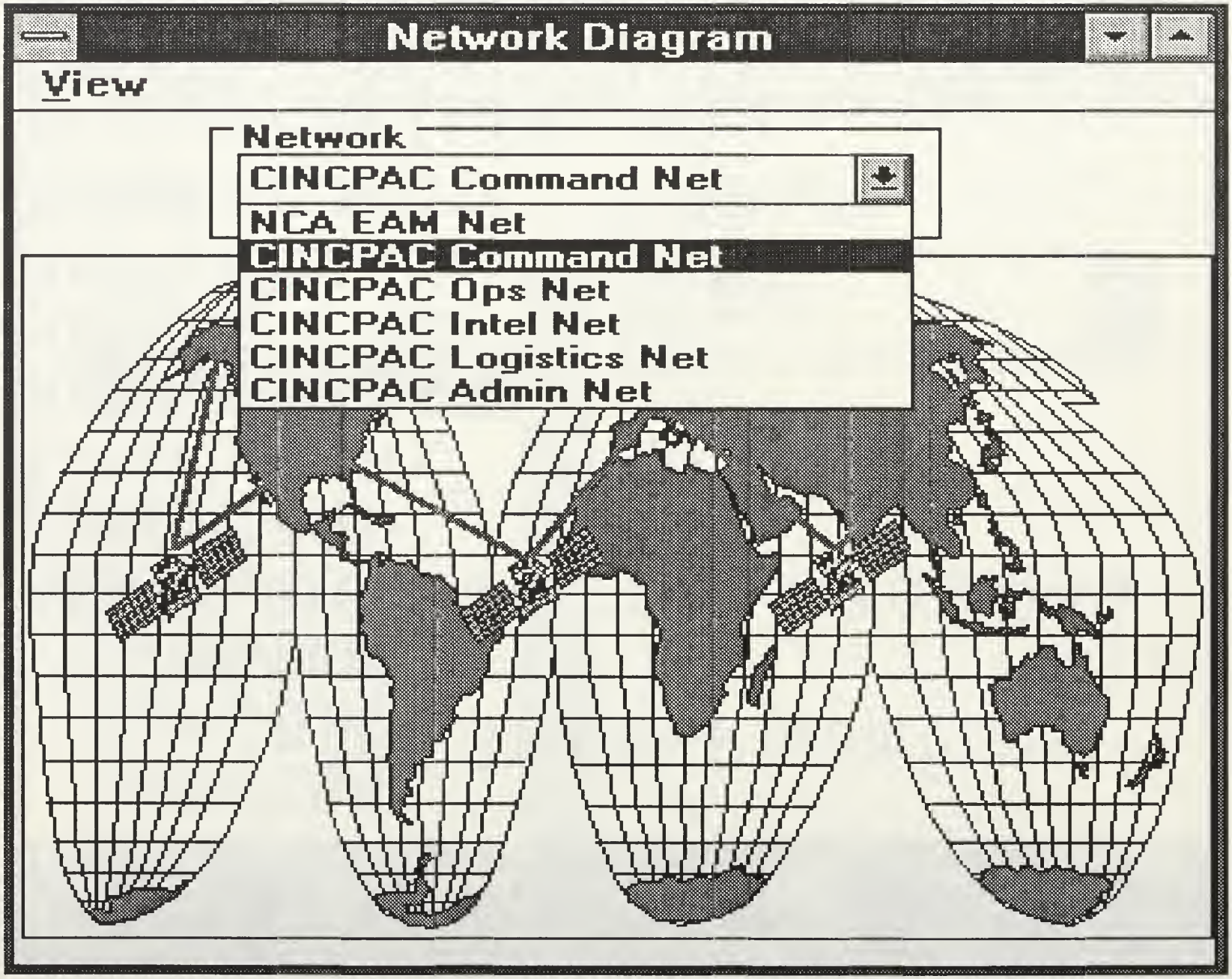
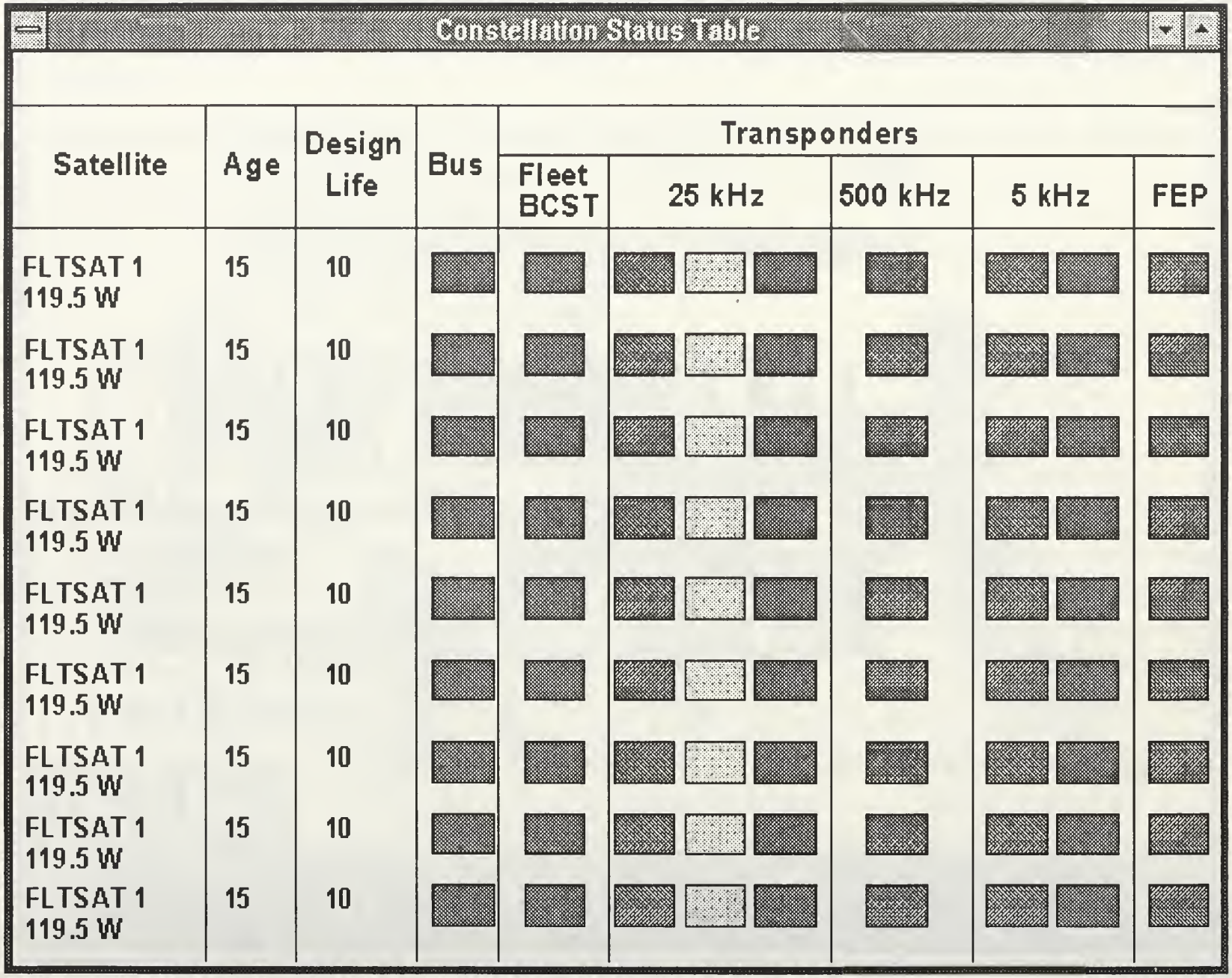

Network Diagram
View
Network
CINCPAC Command Net
NCA EAM Net
CINCPAC Command Net
CINCPAC Ops Net
CINCPAC Intel Net
CINCPAC Logistics Net
CINCPAC Admin Net

Bandwidth Usage
Domain
Longitude
Constellation
Satellite

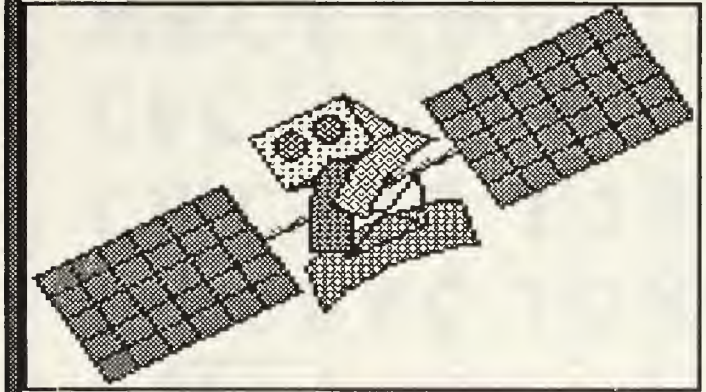


Satellite	Age	Design Life	Bus	Transponders				
				Fleet BCST	25 kHz	500 kHz	5 kHz	FEP
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						
FLTSAT 1 119.5 W	15	10						

Satellite Status Table

Satellite

DCSC III PAC



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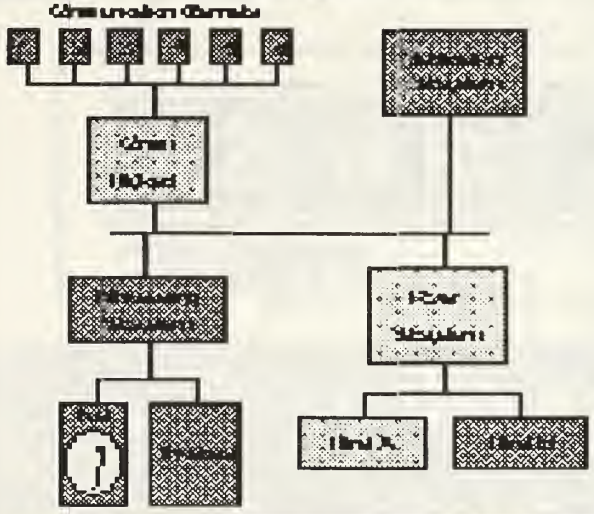


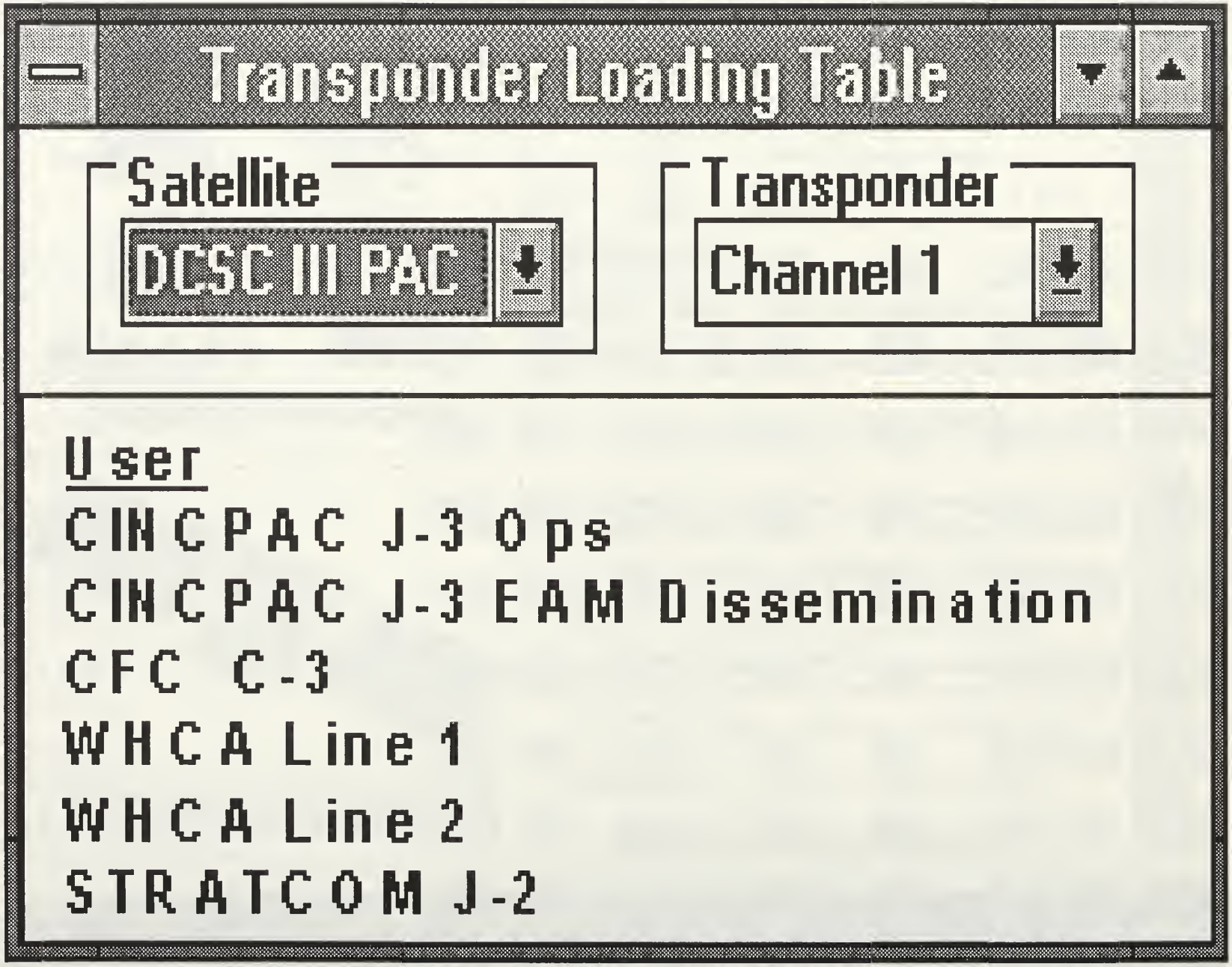
Performance History

Launch: 11 Feb 92 on Atlas MLV-2

Positioning: Geosynchronous at 90W

Chronology:

Date	Event
920213	Arrived at geosynch orbit
920801	Assumed operational mission
930120	...
930213	...
930301	...
930421	...
930430	...
930510	...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Satellite
DCSC III PAC
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CINCPAC J-3 Ops
CINCPAC J-3 EAM Dissemination
CFC C-3
WHCA Line 1
WHCA Line 2
STRATCOM J-2

LIST OF REFERENCES

Bui, T. X., "Designing the User Interface for DSS", unpublished, 1987.

Chairman of the Joint Chiefs of Staff Memorandum for the Secretary of Defense *1993 Report on the Roles, Missions, and Functions of the Armed Forces of the United States*, Washington, DC, 10 February 1993.

Chairman of the Joint Chiefs of Staff Memorandum for the Secretary of Defense *Joint Strategic Capabilities Plan (JSCP) CY 93-95 (U)*, Washington, DC, 30 April 1991. Secret

Chairman of the Joint Chiefs of Staff Memorandum for the Secretary of Defense *National Military Strategy Document (NMSD) FY 1994-1999, Annex C (Command, Control, Communications, and Computer Systems)*, Washington, DC, 19 June 1992.

Davis, G. B. and Olson, M. H., *Management Information Systems: Conceptual Foundations, Structure, and Development*, McGraw-Hill Book Company, New York, 1985.

Kamel, M. N., and Hsiao, D. K., *Interoperability and Integration Issues in Heterogenous Database Environments*, Computer and Administrative Departments, Naval Postgraduate School, Monterey, CA, undated.

Marcus, A., "Designing Graphical User Interfaces", *UnixWorld*, Vol 7, Number 9, Sept 1990, p.122.

Marcus, A., "Designing Graphical User Interfaces", *UnixWorld*, Vol 7, Number 10, Oct 1990, p.137.

Microsoft Windows Software Development Kit Guide to Programming, Microsoft Corp., 1990, pp. 1-5.

Rockart, John F., "Chief Executives Define Their Own Data Needs", *Harvard Business Review*, Jan-Feb 1979.

Microsoft Windows Software Development Kit Guide to Programming, Microsoft Corp., 1990, pp. 1-5.

Rockart, John F., "Chief Executives Define Their Own Data Needs", *Harvard Business Review*, Jan-Feb 1979.

Sprague, R. H., and Carlson, E. D., *Building Effective Decision Support Systems*, Prentice Hall, Inc., 1982.

Title 10, United States Code, *Goldwater-Nichols Act of 1986*, Washington DC, 1986.

Turban, E., *Decision Support and Expert Systems Management Support Systems*, 3d Edition, Macmillan Publishing Company, New York NY, 1993.

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